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Field Days at the Mackay and Meringa Sugar Experiment Stations.

By W. J. S. SLOAN.

ANNUAL Field Days were a feature of the activities of the Sugar Experiment Stations in pre-war days, and it was a matter for regret that they had to be discontinued during the critical years of the war. The Sugar Experiment Stations Advisory Board was particularly desirous of reviving the practice of holding Field Days but drought and reorganisation of the Bureau staff last year made this impossible. However, this year it was considered that there was sufficient interesting material on the Sugar Experiment Stations at Mackay and Meringa to warrant holding Field Days and accordingly they were held at these Stations on June 18th and on June 20th respectively. Conditions on the Bundaberg Station were not suitable for a Field Day.

The method of conducting visitors around the many points of interest on the Stations was varied in that small groups were placed in the personal charge of individual officers of the Bureau, instead of one large group moving *en masse* around the Stations under the supervision of only one speaker. This departure from previous practice was warmly welcomed as it permitted greater freedom for discussion and the interchange of views between the visitors and Bureau officers.

The Field Days at both Stations were very successful and of considerable interest to visiting farmers, officials of the sugar industry and those concerned with the development and progress of the respective districts. Approximately 350 people attended the Field Day at Mackay and 140 at Meringa. The attendance at the latter Station would no doubt have been much greater, had not a break in the showery weather which had hindered farm operations for some time, provided favourable conditions for planting and so kept many farmers busily occupied.

At each Field Day, the newly appointed Director, Sugar Experiment Stations, Mr. E. R. Behne, welcomed the gathering. Mr. A. F. Bell, who has relinquished his post as Director, Sugar Experiment Stations, and is now the Under Secretary of the Department of Agriculture and Stock, addressed the visitors and in saying farewell reviewed

the progress of the industry since he had first been associated with it. Mr. L. G. Vallance, Chemist, discussed farm fertility investigations and fertilizer trials. Talks were also given at Mackay by Mr. W. A. McDougall, Entomologist, on the experimental work being carried out for the control of wireworms with "Gammexane," and at Meringa by Mr. J. H. Buzacott, Entomologist, on the investigation of cane grub control with the same chemical.

Other speakers at Mackay included Messrs. F. Graham, M.L.A., J. W. Inverarity, Deputy Chairman of the Sugar Experiment Stations Advisory Board, R. Muir, General Secretary of the Cane Growers' Council, and W. Holding, Chairman of the Mackay District Cane Growers' Executive. At Meringa, Messrs. W. L. Poustie, a member of

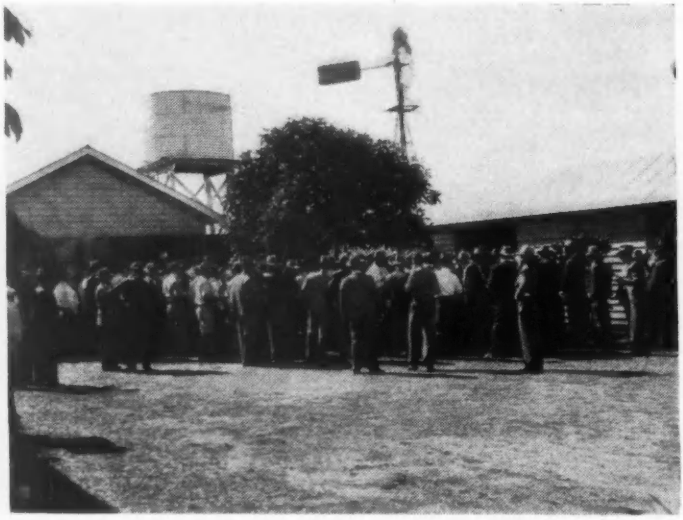

FIG. 1.—Lunch time at the Mackay Field Day.

the Sugar Experiment Stations Advisory Board, R. H. Watson, Chairman of the Cairns District Cane Growers' Executive, and E. M. Bennett, Chairman of Directors, Mulgrave Mill, also briefly addressed the audience.

In past years it has been customary for Manufacturers and Agents to display a comprehensive exhibit of farm machinery and implements at the Sugar Experiment Stations on Field Days, but because of acute shortages and transport troubles it was not possible on this occasion to show as many as formerly. Appreciation is expressed to J. Michelmore & Co. Pty. Ltd., Pioneer Motors, and Mr. A. Breadsell of Mackay, and to the Cairns Agents of International Harvester Co. and Mr. P. F. Tierney, Innisfail, for the equipment which they exhibited.

The addresses by Mr. A. F. Bell, Under Secretary of the Department of Agriculture and Stock, and officers of the Bureau of Sugar Experiment Stations are reproduced below—

Address by Mr. A. F. Bell.

"As you know, my period of service in the sugar industry has now ended. In addressing you to-day, therefore, it may be of some interest and of some value to review the technical progress in the field since I entered the industry nearly 20 years ago, and also to make some attempt to look into the future.

"Although, when one is in day to day contact with technical problems the rate of progress often seems maddeningly slow, on looking back there is no doubt that we have come a long way in the last twenty years. I think we may in justice claim that the technical efficiency of

FIG. 2.—A group at the Meringa Field Day.

sugar cane production in Queensland is second to no primary industry in Australia. At the same time, I think we are all fully aware that the industry has still much to gain from a continued, and indeed intensified, programme of technical research.

"That we have registered a great deal of progress in the understanding and usage of fertilizers may be better appreciated when I remind you that when we returned to this country in 1928, it was no uncommon thing to see farm leases, or conditions of time purchase, which prohibited the use of sulphate of ammonia. Any man who wrote such a clause into a lease now would probably be regarded as a fit subject for incarceration. In the years between we have carried out hundreds of field fertilizer trials in association with soil surveys and thousands of soil analyses. The general fertilizer requirements of every farm are known and there is no reason for any cane grower to waste money by using the wrong type of fertilizer. The investigational programme can now be refined to determine economic rates of fertilizer application with

more accuracy, and to study adjustments in methods and time of application. Moreover, the starving of our soils during the war years has made necessary a re-survey of fertility levels and this is being carried out as fast as possible.

"Another phase of future work will be the maintenance of a constant check on requirements of minor plantfood elements. We have become accustomed to think of fertilizer only in terms of nitrogen, potash, phosphate, and lime, but plants require very small quantities of a number of other elements such as manganese, boron, and copper. As

FIG. 3.—From left to right: Messrs. A. F. Bell, Under Secretary, Department of Agriculture and Stock, J. W. Inverarity, Deputy Chairman of the Sugar Experiment Stations Advisory Board, and F. Graham, M.L.A., discuss seedling raising at Mackay.

soils become older, we must expect that some of these will become deficient and already we have found evidence of such a deficiency in one district.

"The varietal picture has changed beyond recognition in the past two decades. Of all the varieties grown on a commercial scale in 1928, only four now contribute more than one per cent. of the crop, and all, including the proud Badila, are declining in importance. The vanished varieties have been replaced mainly by locally bred seedling canes, and to a less extent by imported varieties, which are better able to withstand disease and whose stronger rooting systems enable them to maintain crops in the face of declining soil fertility.

"Great advances have been made in the technique of seedling raising, and in the preservation and storage of cane seed. Over 1,000,000 seedlings, each representing a distinct variety, have been grown to maturity, examined, and selected or discarded since 1928. Seedlings are now being raised and tested at Meringa, Babinda, Ingham (by the Colonial Sugar Refining Company), Mackay, and Bundaberg, while plans have also been made for the development of a breeding station on

the Lower Burdekin. In Mackay, in spite of the phenomenal success of Q.28 and Q.50, it is proposed to carry out a second series of propagation and selection on a soil type which is richer than that of the Experiment Station; by this means it should be possible to evolve the right type of seedling for soils of varying quality throughout the central district.

"Variety production and testing is a phase of Experiment Station work which should, and indeed must, be intensified in the future. Fertilizers, drainage, irrigation, &c., all promote increased returns but all involve the outlay of money; on the other hand, an improved variety grows increased yields without added expenditure. Moreover, while good farmers are already approaching the limits of improvement in their methods of crop production, there is always room on top for a better variety.

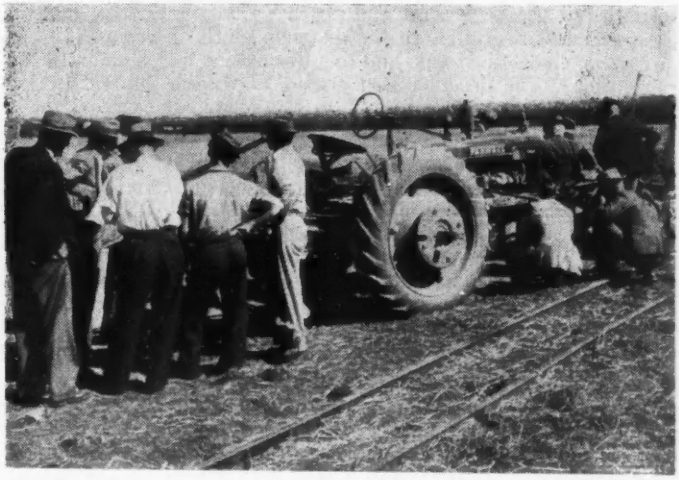

FIG. 4.—Farmers examining agricultural machinery on display at Mackay.

"Up to the present, the Bureau has had to carry on without the services of a specialist cane breeder—we have all had a hand in seedling production. In the circumstances remarkably good progress has been made, but we cannot be satisfied until this important staff deficiency is remedied.

"In the initial stages of the Bureau's expanded field programme emphasis was rightly laid on fertilizer and varietal trials. These investigations have now become more or less stabilised, and the time has arrived when the necessary staff and facilities should be developed for the purpose of making a thorough examination of methods of cultivation. Our agricultural heritage is that of the British Isles and Western Europe and here, under entirely different climatic conditions, our cultivation practices are too much influenced by tradition. Intensive research is required to develop cultivation methods more suited to our hot climate with its alternating periods of excessive rain and drought.

"Pests have always been an important adverse factor in the cultivation of sugar cane. A great deal of investigation has been made into the habits of these pests and their stages of greatest vulnerability, but

satisfactory control has often been impeded by the high cost of poisons and fumigants. The wartime stimulus to chemical research has greatly increased the range and efficiency of chemical pesticides, fungicides, and weedicides. The results already being obtained with such substances as "Gammexane," D.D.T., and "Methoxone" hold out considerable promise for an intensified war on plant and animal pests.

"It is perhaps in the field of disease control that the greatest advances have been made. Queensland has the doubtful distinction of having all the major cane diseases with but one exception. In 1928 the sugar industry of southern Queensland was threatened with extinction by gumming disease, while downy mildew, Fiji, and a host of minor diseases were taking toll of cane crops in many areas. To-day, through the development of resistant canes, the rigid control of varieties, and the activities of the Cane Pest and Disease Control Boards, losses from disease are almost negligible in the districts south of Townsville. North of Townsville, chlorotic streak, and to a less extent leaf scald, still require some attention. The decentralised system of disease control by legislatively created local boards is unique in the sugar cane world, but it has fully demonstrated its efficiency here.

"Methods for combating soil erosion and the gradual loss of soil fertility must soon be given very serious attention. We have cultivated land where slopes are too great for cultivation; ploughed straight up and down slopes; and practised bare fallowing. As a result there are considerable areas where virtually the whole of the surface soil has been lost while some damage has been done in all areas where the slope is more than three or four per cent. Much experimental work has been carried out in America to determine suitable methods of soil conservation, but it has been done in zones of comparatively low and gentle rainfall; Queensland conditions will need special research.

"The problem of the maintenance of soil fertility has now become urgent. Constant cultivation and heavy cropping of a single crop has depleted the soil of plantfoods and organic matter, reduced its moisture-holding capacity to somewhere about half, deteriorated its structure, and built up the numbers of root attacking parasites. Soil fertility is by no means merely a matter of plantfoods and the compensation of the depleted plantfood supply by the judicious use of fertilizers; but the serious loss of tilth, organic matter, and moisture-holding capacity can only be arrested by a marked change in our cropping methods. In other words, soil must be *farmed* if the heritage of succeeding generations is to be preserved. It is a serious and difficult problem which requires the earnest attention of all in the industry.

"Personally, it is naturally with many regrets that I have left the service of this industry, with which I have been associated so long, and which has always been kind to me. It is an industry of which all in it may be proud, and I know that efficiency and progress will continue to be its goals. May I conclude by wishing it permanency and prosperity."

Address by Mr. L. G. Vallance.

Before dealing with the main subject of his talk at Mackay, Mr. Vallance referred to a Station trial where an endeavour was being made to obtain further information regarding the use of filter cake as a fertilizer. "Probably one of the most frequent enquiries addressed to Bureau officers," he said, "is 'What is the value of filter mud, and if

filter mud is used, should it be used with or without the addition of fertilizer?' Quite frankly, this is a very difficult question to answer and it would appear that many factors must be considered.

"At first sight it seems a relatively simple matter to carry out a chemical analysis and so estimate the amount of nitrogen, phosphoric acid and potash which would be applied per acre per ton of mud. The difficulty is, that although appreciable amounts of plant nutrients may be applied in the form of mud, they do not become available until the organic material contained in the mud has become decomposed. This requires soil moisture and warmth, and here immediately we must realise the control imposed by weather conditions. On non-irrigated farms under such dry conditions as those which Mackay experienced last season, I do not think that the decomposition of filter mud is rapid enough to provide sufficient plantfood to justify the cost of carting. On the other hand, with good seasons, or under irrigation, our observations are that mill mud may be used with very beneficial effects.

"A point that we hope our trial might elucidate is whether, under dry farming conditions, it is necessary to apply, along with the mud, some readily available plant food in the form of fertilizer. An argument in favour of the use of mud, and one which must be seriously considered, is the fact that a heavy dressing will provide a considerable amount of organic matter. This will ultimately break down to form humus, which is so much needed in our Mackay soils. Another point worth noting is that the lime content of mud may be appreciable, and a recent analysis showed that in a dressing at the rate of 50 tons per acre, the amount of lime applied was approximately 4½ tons per acre. If only because of these last two considerations, we feel that we should persist with trials designed to reveal the most effective methods of utilising filter cake."

At Meringa, Mr. Vallance prefaced his address by a reference to a Station trial where the influence of potash fertilizer on C.C.S. values was being investigated. "We have long known," he stated, "as the result of many fertilizer experiments, that potash when applied as a fertilizer has a tendency to increase the sugar content of cane cut early in the season. It was felt that this was due to the hastening of maturity of mid-season and late varieties.

"The trial which has been set out has been designed to determine whether potash is more effective in influencing the sugar content when applied as a top dressing rather than at planting. It may quite well be that the newer varieties can be stimulated to produce earlier sugar by regulating the time of application of potash. Since this fertilizer is a water soluble one there is no practical reason why it cannot be applied either in conjunction with the usual top dressing of sulphate of ammonia or as a separate application. We do know, quite definitely, that there is a close relationship between the uptake of nitrogen and potash in the cane plant. This has been indicated very significantly by some trials recently harvested on the Bundaberg Station. It is hoped, therefore, that the small trial which has just been set out may provide interesting data on the possibility of providing early sugar and assist in our search for some practical method of controlling maturity."

The remainder of Mr. Vallance's address at each Station was as follows:—

"And now I should like to leave the matter of Station trials since these will have been fully described by other Bureau officers during the tour of the Station and turn to another phase of our soils, fertilizers.

and general plant nutrition investigations. I refer now to our 'Farm Fertility Trial Programme,' which is carried out on growers' properties and which has always been regarded as a very important part of the Bureau's activities. During the war years this work had, of necessity, to be drastically curtailed. But we were in the happy position of having available a considerable amount of reasonably precise information regarding the fertilizer requirements of our many and varied soil types. This enabled us to utilise to the best advantage the greatly reduced supplies of fertilizer that were procurable during the rationing period. For instance, soils which were known to be markedly deficient in potash were given Priority No. 1 for this essential plantfood, and such was also the case for phosphoric acid. I think that we can justifiably claim that the soil testing service provided by the Bureau and carried out in conjunction with the farm trial programme has contributed in no small measure to the generally efficient way in which fertilizer is used in the sugar industry. I bring this fact to your notice in order to remind you that the soil testing service is still functioning, and it is in your own interests to take the fullest possible advantage of it. To any of you who may be doubtful as to whether the most suitable fertilizer is being used for any particular block, I would suggest that a soil sample be forwarded to us for analysis.

"Therefore I might enlarge for the moment on the best procedure for submitting a sample for analysis. First of all, I would suggest that you contact your district Adviser in Cane Culture, since as the result of his experience he can, in many cases, advise you of the correct fertilizer mixture simply by recognising the soil type. Alternatively, he will sample the field and forward the required amount for analysis. However, it cannot be denied that our district officers are very busy people, and it may be impossible for him to pay you a visit within a reasonably short period. There is no objection to the taking of the sample by the farmer himself providing one or two simple rules are adhered to.

"The first precaution to be observed is the time of sampling. For certain reasons, which I shall not discuss at the moment, the most suitable time to sample cane land is when it is under a crop of cane that is about full grown, preferably around about harvest time. A good general rule to follow is to take one sample per acre for blocks over three acres in extent—for instance, with a ten-acre block, you would take ten samples. These individual samples would be placed on a bag and thoroughly mixed together, and from this mixture a final sample of about 2 lb. in weight would be selected and forwarded for analysis. To take each individual sample, first dig a hole 10 inches deep, then with a spade take off a slice down one side about 2 inches thick from top to bottom. Such slices taken from the different sampling points of the block are mixed to provide the final sample. For land less than three acres in extent it is advisable to take not less than three sub-samples. It is important to remember that where more than one soil type occurs in the block each type should be sampled independently. It would not be advisable, for instance, to composite sub-samples from a red volcanic soil with those from a grey sandy loam. A final request in this matter is that you forward with the sample full particulars as to previous fertilizing history, growth of the present crop, slope of land, depth of soil, and drainage.

"In conclusion, I would like to thank all those growers present to-day who are cooperating in our 'Farm Fertility Trial Programme' by making available the required land and labour and who are putting up with the numerous inconveniences that go towards making this experimental work a success. We have a heavy programme this year for this district, and many of you have already indicated your willingness to cooperate. As Mr. Bell has already outlined, a great deal of the fundamental work regarding the use of fertilizers has been completed, and we are now seeking to refine and improve the methods of using these fertilizers particularly as regards time of application. We believe this to be important, in so far as it may concern the early sugar content of the major district varieties."

Address by Mr. W. A. McDougall at Mackay.

"During the past eighteen months the new British insecticide, 'Gammexane,' has been given a great deal of publicity in sugar districts.

"Most of the introductory experimental work with this material against cane grubs has been done in the north, as these pests were not present in any great numbers in this district during the past season. The one plot set out here against grubs was abandoned at an early date. Actually the last grub season was a poor one for experimental work in the north too. However, from the information available at the present, the most effective method of applying 'Gammexane' against 'grey-back' grubs is by distributing it in a broad band close to each side of the row of young cane at the rate of 100 lb. per acre before the beetle flight. Cost of material approximates £5 per acre. Results in ratoon cane are still indefinite and they have not been encouraging against 'frenchi' grubs. It is very obvious that a large amount of experimental work has yet to be done with 'Gammexane' to establish its true worth as a grub control under Mackay conditions.

"Now the use of 'Gammexane' against wireworms: As is well known these insects, as serious pests of cane, are more or less the concern of the Central districts to the farmer on forest land, only where they may cause more trouble than grubs.

"Last spring in trials against wireworms 'Gammexane,' at the rate of 20 lb. per acre, when mixed with No. 1 Planting Mixture and carefully applied during ordinary planting operations, gave very promising results under the dry conditions encountered. In fact these results are the only positive ones obtained so far with any chemical against these pests. The cost was about £1 per acre. This chemical damages young cane roots if it comes into contact with them, and to avoid this the fertilizer containing it was dropped through adjusted chutes, slightly in front of the 'run-in' of soil on the plant.

"During this coming spring it is hoped that the trials of last year can be repeated and extended over a wide area. A bad wireworm season is not expected, and therefore any farmer who knows he will be planting bad wireworm country can help considerably if he notifies this Station that he is willing to do his share by taking a small 'Gammexane' versus wireworm trial. The lay-out of these trials is simple and will not interfere unduly with planting.

"It should be pointed out that the mixing of 'Gammexane' and fertilizer is definitely not a farm job. Therefore, the sooner the necessary experimental work is over—and provided, of course, that 'Gammexane' fulfils its present promise—then the sooner 'Gammexane'-fertilizer mixture will be available for general use against wireworms."

Address by Mr. J. H. Buzacott at Meringa.

"In view of the very serious grub damage which was widespread throughout North Queensland during 1946, great interest has been evinced of recent months in the possibilities of 'Gammexane' as a medium for grub control.

"Although in past years fumigation with carbon disulphide has been in some degree a palliative, control with this material has become gradually more costly and difficult so that at the present time it is less favoured as a fumigant for cane grubs than it was formerly. This is not due to any difference in the constitution of the carbon disulphide but rather to the following causes. Firstly, with rising costs, carbon disulphide has increased in initial cost whilst the lack of shipping has necessitated the more costly form of rail transport. Secondly, the cost of labour for application, when obtainable, has increased greatly, and although this cost has been offset by the development of mechanical fumigating machines, it is not all cane that can be fumigated by mechanical means. Thirdly, since the initial grub attack on the stools commences during the wet season it follows that soil fumigation must be carried out during the short breaks of fine weather that are sandwiched in between the monsoonal rains; again, because the percentage kill obtained with carbon disulphide is governed largely by the moisture content of the soil, it follows that weather conditions at that period can influence the fumigation campaign to the extent of its being highly successful, or on the other hand, a partial failure.

"In view of the disabilities associated with the use of carbon disulphide it is little wonder that small plots at the Sugar Experiment Station which were treated during 1945 with a new chemical insecticide, evoked considerable interest when they indicated that efficient control of grubs was obtained with comparatively small applications of the substance.

"The chemical responsible for these results is known as 'Gammexane' and it is a rather complicated form of a comparatively simple substance called benzene hexachloride. The material was originally produced in concentrated form by chemists of Imperial Chemical Industries Pty. in England and to this firm we are indebted for the supplies of this substance with which to conduct our trials.

"Small supplies of both 'Gammexane' and D.D.T. were first received for trial during the latter part of 1945. Accordingly, they were set out as soil dressings in small field trials prior to the 1945 beetle flights. When the beetles flew, small cage trials with adult beetles were also carried out. In the cage trials it was soon found that cane beetles succumbed rapidly in soil treated with very small amounts of 'Gammexane' and in view of this fact the subsequent performance of the field trials was watched with interest. These field trials were first dug to determine grub populations early in March, 1946, and from the first diggings it became evident that although untreated areas were heavily grub infested, plots treated with 'Gammexane' had by that time a comparatively low infestation. In D.D.T. treated plots there was some reduction in grub population but not sufficient to prevent damage to the cane. A second digging made during April showed that whilst the untreated plots still carried a fairly heavy population, that of the 'Gammexane' treated plots was reduced to almost nothing. By this time it was evident that untreated areas were checked in growth compared with the treated plots.

By May this difference became very marked and when the tops of the cane in the untreated area browned off and died, the appearance of the plot was most spectacular.

"In view of the effective control obtained from the material applied during 1945 it was decided to treat field plots on a very large scale during 1946 so that a rapid evaluation could be made of the material for use on a commercial scale. Plots were accordingly established to determine the most effective time to apply the poison, the most effective method of application and the minimum quantity necessary for effective control. The plots were located in several mill areas in order to ensure that the trials would be carried out in various soil types, and under differing climatic conditions.

"With this ambitious programme it was hoped that a very considerable amount of information regarding the use of the insecticide would be gained. Unfortunately, from our point of view, the very widespread drought throughout all northern cane areas during 1946 had such a marked effect on the beetle and subsequent grub infestations for 1947 that, of the total number of plots set out, only a small percentage became grub infested. Furthermore even in the few areas which were grub infested the infestations were comparatively light and also late. The consequence is that results, which in a normal season would have shown up two months ago, are only now becoming evident.

"Whilst we are naturally disappointed that only meagre information has been gained from experimentation on such a large scale we are happy to be able to say that in all instances where grub infestation occurred and the 'Gammexane' was applied prior to the beetle flight, good control of greyback grubs has been effected and this at least corroborates the results obtained during 1945-46.

"Whilst it is generally our policy to test out a new fumigant very thoroughly before recommending it for general use, the interest in 'Gammexane' is so great and the demand for an effective fumigant so immediate that we are prepared to make certain restrained recommendations as to its use for those farmers who desire to apply it durng the coming spring.

" 'Gammexane' is at present on the market as a 10 per cent. dust which contains approximately 1.3 per cent. of the poisonous principle and in which the chemical is diluted with a light inert powder called pyrophyllite. Extensive tests, both at the Meringa Experiment Station and on farms in several mill areas have shown that it has no harmful effect on cane growth when applied in accordance with our recommendations.

"In the light of our experiments to date, the method of application which has proved effective is to apply the material in the form of a band some eighteen inches wide along the cane row. This should be done for preference at some period before the drill is filled in; subsequent cultivation will distribute the 'Gammexane' thoroughly through the soil near the stool. Experiments have shown that the insecticide is effective even when applied as early as August or as late as just prior to the beetle flight, so that considerable latitude is allowable in the time of application. Since the dust is very light it is advisable to apply it either early in the morning or on a comparatively windless day, otherwise considerable quantities of it may be blown away. The rate of application at present recommended is 100 lbs. per acre of the 10 per cent. dust. Whilst it

may be possible at a later date to recommend lower rates of application, our experiments so far have indicated that 100 lbs. will give adequate control. Application must be carried out at present by hand or by a converted fertilizing machine, although an ingenious farmer could easily build a small machine capable of applying the dust. The present cost quoted by the firm dealing in the material is ten pence per pound in capital cities which would probably bring it to about eleven pence per pound on the farm.

"Although there is some evidence to indicate that partially successful results may be obtained in some instances even when 'Gammexane' is applied after beetle flight, our experimental results are not yet sufficiently complete to make any recommendations regarding its application after beetle flight. At present, therefore, it will be mainly used by farmers who suffer severe grub damage practically every year and for whom its application prior to beetle flight might be regarded as a form of crop insurance.

"The methods of application of 'Gammexane' mentioned above apply to control of the grub of the greyback beetle. The same method of application has not proved particularly successful against 'frenchi' grubs and further experiments are necessary to determine whether other methods of application will be more successful in controlling these grubs.

"Advantages which favour the use of 'Gammexane' for grub control are the fact that it is not toxic to human beings; it constitutes no fire hazard and it is far less unpleasant to handle than carbon disulphide, whilst the fact that it remains potent in the soil for at least several months is a valuable feature.

"Although much further investigational work is still necessary it seems probable, even with the present limited knowledge of its application, that 'Gammexane' will prove a most useful agent in the control of cane grubs over a large portion of the areas commonly affected at present."

The Need for More Varietal Trials.

By NORMAN J. KING.

HOW often do we hear a grower make such a statement as "That variety may suit your conditions, but it is no good on my farm"? There is only one satisfactory method of proving the value of new varieties on all soil types and under varying conditions of rainfall or irrigation, and that is the properly planned varietal trial. It is obviously impracticable to have such a trial on every farm, and we must be satisfied with a range of trials under the average conditions of a given area or sub-district. Results of a trial planting on an average property are, in general, applicable to a large number of farms on a similar soil type in that vicinity and if such a planting is harvested and weighed for the three crops, and sample stalks tested monthly during the harvestable period, much information, of value to the district as a whole, is obtained.

The problem facing the field staff of the Bureau is to find even a small number of growers who are willing to cooperate fully in the

planting of such trial areas. New seedling canes or imported varieties are first tested on the various Experiment Stations, and these trials give valuable results for the particular environment. It is possible then to assess the value of these canes for similar soil and climatic conditions. The next step is to plant promising canes in trials on farmers' properties in the various areas served by that particular Experiment Station. Seedlings raised and selected as suitable on the Bundaberg Experiment Station's red volcanic loam with a 43-inch rainfall, may not perform as satisfactorily on the Moreton alluvial lands with a 70-inch rainfall, although it is possible that varieties failing to make the grade under Bundaberg conditions may be more successful in the wetter Moreton area. Similarly, varietal performance on the Northern Sugar Experiment Station at Meringa may not be a guide to a variety's potentialities in the wet Tully area. By the same token, varieties selected at one Experiment Station may show less merit when grown at another Experiment Station with a different climatic and soil environment.

This has long been appreciated by Bureau field staff. and for the past fifteen years a large number of varietal trials have been planted on growers' own properties throughout the length of the sugar belt. The field officer has no difficulty in finding a grower who is agreeable to plant a new variety, if it has any promise at all, but he may have considerable difficulty in obtaining the required cooperation for the planting of a trial with three, four, or more varieties in replicated plots. Reasons given for refusal generally follow these lines—

(*a*) Loss of time in planting the trial;

(*b*) Extra expense in harvesting the trial;

(*c*) Possible loss incurred if sub-standard varieties are included;

(*d*) General disinclination to try new varieties.

It is agreed that a certain loss of time does occur in planting trial plots, but as the trial area constitutes only a small proportion of the area being planted by the grower, the ultimate loss in time is small, particularly as the field officer always assists with the planting. There are very good reasons for the plot method of laying out trials. Growers often ask why it is not just as satisfactory to plant a strip of, say, eight rows of each variety, through the field. The objections to this are—

(1) One variety may be on a better strip of soil than the others; and

(2) There is generally not sufficient cane of new varieties to plant such strips; eight rows in a 10-chain field would mean about half an acre of each variety.

The plot method gives a distribution of five or six plots of each variety scattered through the field, for the purpose of levelling out soil inequalities. Any loss of time is well compensated for by the greater reliability of the final results.

Actually there is no extra expense in harvesting trials. All that is required is the separate weighing of each plot. If the plot is too small or too large for a truck, the field officer attends to the hand weighing of it before the cutters load on to trucks. He also makes the necessary "breaks" to avoid mixing of plots and, in general, supervises the harvesting.

There is always a possibility of slight loss through including in the trial a variety which yields below the standard cane of the farm. At the same time, there is the probability of profit by having one or more varieties yielding higher than the standard cane. Varieties would not be included in farm trials unless it was considered from previous experience that they had a reasonable chance of out-yielding the standard district canes. The possibility of loss, and of profit, is always present in varietal trials, but the trial is the only practical method of evaluating a new variety in terms of tonnage per acre and sugar content, and each grower who cooperates in varietal trial work is making a district contribution to the knowledge of those varieties.

The general disinclination to try out new varieties is common to all areas. The growers, as a whole, contribute largely to the finance of the Bureau, and they can assist in the prudent utilisation of these funds by actively cooperating in the field programme of the Bureau staff.

A single varietal trial in a district is not a reliable criterion of the performance of any cane. The value of a new variety is found by having a large number of trials under a varying set of conditions and then summing up the results as follows:—

> "In twenty trials the new variety exceeded the standard cane thirteen times, was equal to it four times, and was beaten by the standard three times."

From such performance it could be reasonably concluded that the new cane was superior. If sufficient trial areas are not obtained, it is possible that the results may be unreliable for the district as a whole, and the outcome may be the distribution of a variety which later proves unsuitable.

In an endeavour to reduce the inconvenience and loss of time occasioned by planting varietal trials on farms, a change of method has recently been introduced. Instead of planting five or six plots of each variety on one farm as a complete trial, only two plots of each variety are being planted. This is done on as many farms as possible. Regular observations are made on trials by field officers of the Bureau, and then after harvest, yields from all plots on the same soil type are examined together and the average performance of any one variety can be accurately measured. This method has the added advantage that the results of a complete trial are not likely to be lost, as they sometimes were in the past, by an infestation of grubs, the flooding of a plot, accidental stock damage, or some other unforeseen cause.

The advent of the cutter planter has made the planting of varietal trials quicker, and there is a minimum of delay. With the field officer assisting the man on the planter to the extent of indicating where the variety changes in the row, there is little loss of time in changing over at the ends of plots.

Forecast of Approved Varieties for 1948.

In view of the fact that under the past system there has been some doubt as to whether farmers received the new approved variety cards in sufficient time to make planting arrangements conveniently, the Director, Sugar Experiment Stations, has decided to publish the forecast of changes in the approved variety lists for 1948 in the July issue of the Cane Growers' Quarterly Bulletin, that is three months earlier than in past years.

Any interested farmers' organisations which consider alterations should not be made along the lines indicated or wish to submit any other changes are requested to submit their views to the Director, Sugar Experiment Stations, before September 30th, 1947. Any objections against varietal deletions or suggestions for additions *must be accompanied by a detailed statement of the reasons for such objections or suggestions.* No action can be taken in respect of late or unsubstantiated requests.

Proposed changes are as follows and, unless otherwise indicated, lists will remain as in 1947:—

Hambledon.—Eros to be added.

Mulgrave.—North of Fig Tree Creek—Eros to be added. Babinda District—Eros and Comus to be added. South of Russell River—Pompey to be deleted.

Babinda.—Eros and Comus to be added.

South Johnstone.—Pompey to be deleted.

Mourilyan.—H.Q.409 and Pompey to be deleted.

Proserpine.—Trojan to be added.

Farleigh.—Q.813 to be deleted, Trojan to be added.

Racecourse.—Trojan to be added.

Pleystowe.—Trojan to be added.

Marian.—Q.813 to be deleted, Trojan to be added.

Cattle Creek.—Q.813 to be deleted, Trojan to be added.

North Eton.—Trojan to be added.

Plane Creek.—Trojan to be added.

Bingera.—Korpi to be deleted, Q.28 and Q.52 to be added.

Fairymead.—Q.28 and Q.52 to be added.

Millaquin.—Q.28 and Q.52 to be added.

Qunaba.—Q.28 and Q.52 to be added.

Isis.—Q.28, Q49 and Co.301 to be added.

Moreton.—Q.813, Q.25, Oramboo and P.O.J.213 to be deleted; Q.47, Q.49 and Vesta to be added.

Rocky Point.—Korpi to be deleted.

Some Administrative Aspects of Irrigation.*

By ARTHUR F. BELL.

Introduction.

IN a report on "Irrigation Water Conservation and Land Drainage" presented to the Commonwealth Government in December, 1945, the Rural Reconstruction Commission states, "The Commission accepts the view that *water will ultimately be one of the most important of all commodities in the Australian economy.*" In summarising their conclusions on the availability of water the Commissioners further say: "The possibilities of increasing Australia's irrigated acreage, although considerable, are not as great as is popularly supposed. Ultimately, shortage of water will be the greatest of the obstacles to increased population. For this reason, and because the allocation of the water of a catchment once made cannot easily be changed, it is desirable that the use of the available waters should be carefully planned and that irrigation should be given priority over electricity generation."

The recent—and, in some areas, the still-current—disastrous drought has inevitably turned the thoughts of Queenslanders towards irrigation. While this interest has waned with the coming of relief rains, it nevertheless does appear that the trials of the past two years have awakened a lasting public consciousness of the pressing necessity for development of our water resources. Queensland, in common with its sister States, is a land of deficient and uncertain rainfall,† and our agriculture is to a marked extent adversely influenced by the vagaries of climate. Since the progress of this State is so intimately integrated with primary production, it follows that stability will be attained only to the degree that primary production is stabilised by the widespread development of irrigation and of practices designed to ensure a better exploitation of our summer rainfall.

Previous papers presented to this Society on the subject of irrigation have dealt mainly with the field technique of water application and its effects on soils and crop yields. The purpose of this paper is to present some observations on the investigations, planning, and administrative work which must precede and accompany the successful launching of an irrigation "scheme." There exists a great deal of misconception regarding the practicability and cost of irrigation schemes and their effects on the community, the availability of water for irrigation, the volume of reservoir storage required, and the losses of water in storage and in transit to the fields. As I commence to write, I note that the quotation for the day on my desk calendar is, "Getting rid of a delusion makes us wiser than getting hold of a truth"; it is hoped that this paper may both dispel some delusions and submit some truths.

Sources of Water for Irrigation.

Irrigation water may be obtained from three ultimate sources: (*a*) from wells and bores which reach underground water-bearing strata or aquifers; (*b*) from reservoirs created by dams or weirs thrown across

* Paper presented at Innisfail Conference, Q.S.S.C.T., May, 1947.

† The Irrigation Department has recently compiled and published a series of graphs which clearly illustrate this factor of unreliability.

streams and impounding the water of those streams and their tributaries; (*c*) from natural unregulated streams. All three sources are widely exploited, the lastnamed being the least important since the water available is least in time of drought when the need is greatest.

This State is fairly well served by underground water supplies and further investigation might well show that it is, in fact, very well served; in this respect its resources appear to be much greater than is the case in the other States of the Commonwealth. The advantages of subsurface water are that it can be used for irrigation right at the source of supply; no costly headworks and reticulation channels are necessary; there is no loss of water from storage by evaporation; and pumping from the wells facilitates the use of sprays which bring about economy in water usage. Whereas surface water storage facilities may take years to plan and construct, subsurface water can be used immediately a source of power is available for pumping from wells. Rural electrification with cheap power can therefore play an immediate and important part in increasing the area under irrigation—as has been so well demonstrated in the development of 20,000 acres of irrigated crops in the Lockyer Valley during the past decade. In the sugar industry the intensive development of the Burdekin delta is a striking example of successful large-scale irrigation with subsurface water.

The quality of subsurface water is naturally inferior to surface water; greater care is necessary in its use, and research is required to anticipate the soil problems which will certainly arise where well water is used. Such water must always be pumped, whereas stored surface water is usually delivered to farms by gravitation; in view of the cost of this pumping, subsurface water is generally used only for the production of higher-value crops. With these qualifications, the development of our underground water resources can play a very important part in the stabilisation of agriculture in Queensland. The distribution and extent of suitable subsurface water have not by any means been fully established, and a comprehensive State-wide boring survey of these resources would amply repay the expense involved.

In some contrast, Queensland is for the most part poorly endowed in the factors which favour the development of large-scale surface-storage irrigation schemes. The rainfall over most of the State is relatively low, poorly distributed, and uncertain, resulting both in a small run-off into reservoirs and the necessity for large storages to carry water supplies over long periods of drought. The main "dividing" range is close to the coast so that streams in the heavier rainfall areas are relatively short, with steep gradients. There are no snow-capped mountains to store water in the winter and to regulate stream flow in spring and early summer. The country is geologically old, so that mountain ranges are low and there is a great lack of deep narrow-mouthed gorges for use as storage reservoirs. The evaporation rate is high, ranging from about four feet per annum in the south-east, to perhaps ten feet in the north-west; the annual loss by evaporation of the top five or six feet of water is obviously a serious matter in broad shallow reservoirs.

Availability of Water.

In respect of common misconceptions, it is in the visualisation of available water that advocates of particular irrigation schemes are liable to go most astray. People are naturally apt to be misled by the

sight of flood waters if they do not bear in mind that the waters have been drawn from a vast area and that the flood actually covers a small proportion of that area. The bulk of Queensland's good agricultural land lies in the 25 to 30 inch rainfall zone and stream gaugings show that under these conditions the average run-off of rainfall is about four per cent. or *only about one inch per year.* Naturally this figure varies a good deal in particular areas according to topography, type of vegetation, and intensity of storms, but overall the figure is a good enough approximation. In the Condamine River basin on the Darling Downs, for example, the amount of water which ultimately finds its way into the Downs section of the stream is equivalent to less than one inch of rain over that part of the catchment area per year.

The rest of the rainfall percolates down through the soil to lower levels, evaporates from small pools and from the soil surface, or is used up in the transpiration activities of plants. In Victoria, where rivers have been intensively gauged, it has been computed that if all the water in all the streams were impounded it would not constitute more than five per cent, of the annual rainfall.

As rainfall rises above the 25-30 inch bracket, the percentage of run-off increases rapidly: It has been calculated, for example, that of the 61 inch mean annual rainfall of the Barron River catchment area above Picnic Crossing, 25 inches or 41 per cent. runs off in the Barron and its tributaries; corresponding figures for the Tully basin are 92 inches and 56 inches or 61 per cent. However, due to the proximity of the coastal range to the sea, the catchment areas of coastal rivers in the high-rainfall zone are small, and over the greater part of Queensland the average run-off is less than one inch.

Before considering any surface storage irrigation proposal in detail, therefore, it is necessary to have access to stream gaugings in order to determine the quantity of water which will be available for storage. This involves a knowledge not only of average annual stream discharge, but also of its distribution and minimum discharge rates. Stream gaugings made on the Condamine below Warwick by the Irrigation Department indicate that the average annual stream flow over a period of 15 years was 45,500 acre feet, but this fluctuated between 100,000 acre feet in 1927-8 and 14,000 acre feet in 1932-3. Moreover, the minimum discharge of 14,000 acre feet was immediately preceded by the sub-average discharge of 32,000 acre feet. The catchment area involved is about 1,150 square miles, or nearly 750,000 acres. Obviously, any irrigation project involving the full capacity of this river will, to be quite safe, have to provide for the storage of about two year's supply of water—and to restrict the area which can be irrigated.

Siting of Irrigation Works.

Should the study of rainfall and stream-gauging records indicate the availability of a reasonable volume of water, it then becomes necessary to seek a site, for the construction of a dam, which will be suitable both as to topography and foundations. Contour surveys must also be carried out in order to determine the capacity of the proposed reservoir at different heights and also, and this is important, determine the area which would be submerged. As emphasised earlier,

the smooth topography of much of Queensland does not make for good dam sites and it is possible for the contour surveys to show that, say, 3,000 acres of good river-flat land would have to be submerged to store sufficient water to irrigate 5,000 acres. Compensation for the loss of the submerged land would in such case add a serious burden to the capital costs per acre irrigated.

Having determined the site, capacity, rate of replenishment, and approximate cost of a dam of given height, it is necessary to determine whether land of required topography, texture, and fertility is suitably situated for irrigation from the reservoir. In the past many irrigation settlements have been established only to fail through unsuitability of the soil or its drainage. Irrigation and drainage are complementary and, if success is to be assured, they must be planned and established concurrently on the basis of intensive soil surveys. In the Murrumbidgee Irrigation Areas, some 6,000 acres of citrus orchard, with an annual productive capacity of well over £100 per acre, were reported in 1943 to be in a serious state if ill-health. Investigation showed that this was due to poor drainage caused by "pockets" in the sub-strata which had become water-logged during continued irrigation and particularly as a result of the heavy irrigation of the wartime increased rice plantings.

It is a basic rule in irrigation that water should be used as near as possible to the source of storage in order to minimise wastage through seepage and evaporation. Careful determinations made by the Victorian State Rivers and Water Supply Commission show that of the water which is released from the reservoirs of that State, only about one-third actually reaches the fields; the rest is lost by leakage, seepage, evaporation, and the maintenance of Riparian rights. If we add to this the evaporation and seepage losses in the reservoirs themselves, it will be seen that stored water is far from being delivered water. (As a matter of passing interest, it may be noted that non-observance of this basic rule is one of the defects of the so-called Bradfield Scheme for the diversion of coastal waters of North Queensland to the western part of the State.)

In order, finally, to drive home this matter of water availability, it might be instructive here to make a simple back calculation: Suppose we wish to irrigate 5,000 acres, and that we propose to give it supplementary irrigation to the extent of one and a-half feet per acre, or a total of 7,500 acre feet of water per year. On the basis of Victorian experience of water loss, this would entail the delivery from the reservoir of 22,500 acre feet, and allowing for reservoir losses, the storage of, say, 25,000 acre feet. But our rainfall is so erratic in many places that we would have to store two years' supply to leave a reasonable margin of safety, bringing the total required storage to 50,000 acre feet. Let us assume that the catchment area is in the 25-30 inch rainfall zone and that the annual run-off is one inch; then if we wish to fill the reservoir in an average year a catchment area of 600,000 acres would be required. In other words, a catchment of 120 acres would under these conditions supply the water for the irrigation of only one acre.

It is true that in Victoria a good deal of the irrigable land is situated very considerable distances from the storage reservoirs and that, with careful planning, we should be able to reduce these distances

in Queensland; at the same time, however, our average evaporation rates and possibly our seepage rates per mile will be higher. It must therefore be accepted that we shall never be able to irrigate a very great proportion of the agricultural lands of Queensland.

Sponsors of irrigation projects often advance in favour of their proposals the suggestion that flood prevention and power for the generation of electricity will also be achieved. In practice conservation of water for irrigation is largely incompatible with flood prevention and hydroelectric schemes. The fundamental requirements for irrigation and flood prevention are diametrically opposed, since the irrigator's object is to keep the reservoir full, while for flood prevention the object is to keep it empty. Some compromise can no doubt be effected in areas of reliable seasonable rainfall, the reservoir being lowered just prior to the expected onset of the wet season. The generation of electricity for industry requires a steady round-the-year discharge of water from the reservoir whereas irrigation requirements aim at conservation in rainy periods for release during dry periods; at the same time, intermittent generation of power from an irrigation reservoir discharge can be used in subsequent pumping of the same water to the field.

Maintenance of Irrigation Works.

The physical administrative problems associated with surface-storage irrigation schemes do not cease with the construction of the dam and the excavation of distribution and drainage channels. Obviously no scheme could be designed to supply all irrigators on the same day, and complex systems of rotational delivery must be worked out and enforced. Steps must also be taken to see that only the stipulated quantities of water are drawn from the distribution channels. In most places it has been found necessary to provide that water will not be delivered unless the farmer has graded his land and has a suitable system of delivery ditches.

The likelihood of siltation of reservoirs is an ever-present problem. Sites for reservoirs are few and generally irreplaceable, so that if a reservoir becomes silted there can be no question of moving on elsewhere. The protection of watersheds against the soil erosion which causes siltation of reservoirs must henceforth engage the very serious attention of irrigation authorities backed by comprehensive statutory powers where necessary. Senseless felling of trees, indiscriminate burning of vegetation, carelessly caused bushfires, and wrongful land use combine to increase erosion and siltation. One of the oldest reservoirs in Australia, the Laanecoorie on the Loddon River, had a capacity of 14,000 acre feet when constructed in 1892; fifty years later siltation had reduced the capacity to less than half. Following the destruction of ground cover by the disastrous Victorian bushfires of 1937, about 1,000 acre feet of silt was deposited in the Eildon Reservoir during the succeeding twelve months.

Minor Storages.

What has been said in the foregoing pages in relation to large-scale surface storage applies, in less degree, to minor surface storages effected by the construction of weirs within streams. Fixed weirs are usually between ten and twenty feet high, their height being limited by the dangers of flooding caused by impeding the flow of the

channel. The primary function of weirs is stream regulation and they are widely used in conjunction with large reservoirs for this sole purpose. However, when constructed in streams which are more or less perennial, single or multiple weirs may have great value in the absence of reservoirs, as has been amply demonstrated in this State. In these circumstances, they act much in the same way as a car battery, being continuously recharged. Since storage is within the confines of the stream only, the cubic capacity of weir storage is not great and is not usually more than a very few hundred acre feet. As the cost of a weir may be well in excess of £100 per acre foot of storage capacity they are not, as a rule, economic propositions on streams which run for only short periods; exceptions may be found in the case of deep watercourses of low gradient, where water is required for the production of high-value crops such as vegetables.

Control of Water.

The Department of Irrigation licenses all artesian bores, and all sub-artesian bores in the artesian basin, but up to the present there has been little need for the exercise of administrative control of sub-surface irrigation waters. However, most irrigators will agree that in areas where supplies become limited, there should be some measure of control to prevent wastage, or extravagant use of water. It is also becoming evident that the extent of the underground water resources should be determined before development in any particular area is permitted to go very far. Although they have not hitherto been treated as of equal importance the determination of volume of storage and rate of replenishment should be regarded as just as important for subsurface as for surface-storage irrigation schemes. There is inevitably a strict limit to the volume of underground water available to any one area, and to the annual replenishment of that water; if these are disregarded there must be some bad crashes in dry years if farmers are permitted to extend irrigation and pump indiscriminately. Irrigation from wells close to the coast has the added danger of encroachment of salt water if water tables are lowered by over-pumping.

In this connection a very interesting investigation is now being carried out in the Lockyer Valley for the Bureau of Investigation of Land and Water Resources. Following reticulation of cheap electric power in this valley some ten years ago, irrigation developed, and is still developing rapidly. The question arose as to whether the volume of the water in the aquifers, and the wet season replenishment of their annual loss of water, were sufficient to permit continued expansion at this rate. Over the past two years a large number of borings have been made down to the sandstone bottom of the valley so as to furnish some idea of the volume of the aquifer. Over the same period a surveyor's level datum point has been placed on all wells and the standing water levels of a representative number have been read at selected intervals. From these borings some idea has been obtained of the probable volume of the aquifer, while the series of water level readings has shown that the rate of replenishment of this underground reservoir is such that further expansion of irrigation may be confidently encouraged. It might be mentioned in passing, that the borings also revealed the past existence of an old river which flowed under the bed of Lockyer Creek and which was larger than any of our existing rivers.

Economic Considerations.

Thus far we have concerned ourselves only with the physical problems of construction, supply, and distribution of irrigation works and water. There are, however, the equally important administrative questions of finance, economics, and social effects.

It has been generally accepted by people and their Governments that an irrigation scheme, like a highway, is a national asset benefiting the community and as such entitled to a measure of national financial assistance. Consequently we find an increasing tendency for the nation to assume a considerable proportion of the cost of construction of headworks for surface storage and main distribution channels. The remaining cost is frequently met by a special rating on the benefited urban and rural areas plus, of course, a charge applied to the direct beneficiaries—the actual users of the water.

Construction of headworks and reticulation channels involves the expenditure of very large sums of money and cannot be entered upon by Governments or other institutions without a full survey of costs, probable returns, and economic effects, and also of the relative degree of urgency or priority. It will readily be appreciated that capital expenditure can soon rise to a level out of proportion to the value of the land; a dam to store the water necessary to irrigate six or seven thousand acres might easily cost £1,000,000 plus the cost of delivery channels, resumption of submerged land, adjustments to roads and bridges, and so on. The probable use of the land must also be considered when assessing a proposal; for example, water used for the irrigation of tobacco could carry a cost perhaps ten times that which could be paid for water used for producing fodder for cattle.

Social Effects.

Irrigation may have one or both of two objects: (*a*) stabilisation of production, and (*b*) increased production. In prewar days most of the cash crops grown in Queensland were already produced to the limit of their available markets, the notable exceptions being cotton and tobacco. To increase the production of crops with already saturated markets can only lead to chaos; the object of irrigation in these cases should be that of stabilisation by the elimination of alternate gluts and famines. Insurance of crops by irrigation enables planned production, the stabilisation of prices, income, and labour requirements; and should generally reflect itself in a more prosperous and happier community. Moreover, irrigation, by causing the more intensive use of land, brings closer settlement with improved communications, better schools, and better amenities generally.

In submitting proposals for various localities their sponsors do not usually give consideration to the repercussions which their adoption would have in other areas, but the authorities who examine the proposals must necessarily do so when the expenditure of public money is involved. For example, the country's requirements of, say, peanuts, might be grown in Zone "A," a dry farming zone. The citizens of Zone "B" in advancing their claim for an irrigation works might point out that with irrigation they could diversify their farming and, amongst other things, grow peanuts in great abundance. The question then arises as to how far public money should be spent to provide

Zone "B" with an irrigation project which will put Zone "A" farmers out of business. The large-scale development of irrigation bristles with problems like this, and there seems little doubt that as it expands some sort of crop assignment system will have to be worked out.

There are, of course, strict limitations to the degree to which irrigation will effect either increase or stabilisation in primary production. Even though the State, and the general ratepayers of a benefited area, bear a large proportion of the capital costs of irrigation schemes, the "per acre" value of a wheat crop for example, is too low to warrant irrigation under the most favourable conditions. Perhaps it is as well, for these crops require broad acres and there is so much land to which irrigation water can never be brought.

Among major crops for which the visible market is far from saturated we have mentioned cotton and tobacco; but the most important in Australia is undoubtedly fodder, not for immediate sale but for direct feeding to animals. As far as one may judge, an unlimited world market for high quality meat will be available indefinitely if we bestir ourselves to export to its requirements. The development of large areas of irrigated pastures would enable us to produce enormous quantities of high grade lamb and beef, and, what is of paramount importance, would enable continuity of supply. We cannot hope to play a leading part in the chilled beef trade if we are limited to fluctuating seasonal exports. The status of our large dairying and adjunct industries would also be immeasurably improved by the widespread production of irrigated fodder.

By far the greatest development of irrigation in Australia has taken place in Victoria, and it is of interest to note that of 600,000 acres annually under irrigation in that State, 550,000 are devoted to fodder production, mainly as permanent pastures. It seems definite, therefore, that the planning of irrigation in Queensland must contemplate emphasis on animal production.

Conclusion.

The foregoing is a fairly cursory survey of the problems which confront planners and administrators of irrigation schemes. Some of these problems are considerable, but they can all be met; reflection on them should engender discrimination, but not pessimism.

The amount of money which any State can spend annually on irrigation is limited, so that schemes must be put into operation in the order of their productivity, urgency, and feasibility; that any particular proposal is a sound one is thus not sufficient to justify its immediate implementation. There are many economic and technical engineering and agricultural reasons why fair-sized schemes may be preferable to dispersed small schemes. Nevertheless, we should be careful not to err in the opposite direction; a £40,000,000 scheme holds the imagination, but ten £4,000,000 well-distributed schemes would be better for the State—and some of them would be in production years before a gigantic scheme could be completed.

In this dry country our goal must be the conservation of every drop of water which would otherwise run to waste and we should pursue that goal with all the energy and resources at our command.

At the same time, we must maintain a realistic attitude; the green fields of irrigated areas have an emotional appeal and grandiose schemes are often propounded without much knowledge or restraint. Mistakes in irrigation often cannot be rectified, so that sound planning must accompany energy, enterprise, and courage in the development of this priceless asset, water, for which there is no substitute.

The Weed Problem.*

By W. J. S. SLOAN.

Introduction.

A WEED is commonly defined as a plant growing "out of place." Most weeds are useless, some are poisonous to stock, others may harbour plant diseases and pests, while a few are actually parasitic on economic crops; for example, the cane-killing weed (*Striga* spp.). Some plants, which in their proper place are useful, become weeds when they grow amongst other crops where their presence is not desired. For instance, leguminous cover crops are very necessary and useful in the cane rotation, but volunteer plants coming up in the plant and ratoon cane are unwanted and classed as weeds, particularly if the legume concerned has a twining habit of growth such as to interfere with the normal harvest of cane.

Ever since man began to cultivate patches of plants for domestic use, the problem of weed control has been a real one. If unchecked, weeds may add considerably to the difficulties of seed bed preparation, may lower yields and hinder harvesting. Their effective and economic control should be the aim of every efficient farmer, whether he grows cane or any other crop, for weed control can be a prominent item in costs of production. Methods of control have steadily improved, but the need for even better methods still stimulates the ingenuity of farmers, engineers, and chemists, and large industries have been built up to provide the machines required for this purpose in modern agriculture. Weed control by introduced insect parasites has achieved success in some cases, but the cane farmer can expect no assistance in this direction for solving the weed problems in cane fields. Despite much intensive research many difficult weed problems still remain, and there can be no relaxation in investigations to solve them.

In Queensland there is a wide variety of weed species infesting cane lands, but the most important species and those most difficult to handle belong to the grass family, including summer grass (*Digitaria adscendens*, and other species), common couch grass (*Cynodon dactylon*), and Guinea grass (*Panicum maximum*), while nut grass (*Cyperus rotundus*) is well established in a number of areas. Most common weeds are able to survive and grow under conditions of high and low temperatures and can resist drought to a remarkable degree. Species such as summer grass, red pigweed (*Portulaca oleracea*), black pigweed (*Trianthema portulacastrum*), goat weed or Mother Brinkly

* Paper presented at the Innisfail Conference, Q.S.S.C.T., May, 1947.

(*Ageratum conyzoides*), and many others produce enormous numbers of seeds and multiply and spread rapidly, particularly in warm weather when soil moisture is good.

Hand hoeing and the use of cultivation implements, which have steadily improved in quality and variety over the years, constitute the main method of control at the disposal of farmers. Spraying with weedicides has received limited attention, while a new method of control advocated in recent years is the use of "flaming machines" to burn and kill the weeds on the surface of the ground without injuring the cultivated crop. Mechanisation of cultivation equipment has helped considerably to reduce the labour problem and has greatly speeded up operations, enabling weeds to be attacked more readily at the right stage of growth, and fields to be covered more rapidly than was possible formerly with horse-drawn implements.

WEED CONTROL BY CULTIVATION.

Crop rotation, efficient seed bed preparation, the judicious use of implements for inter-row cultivation and, to some extent, hand hoeing are all necessary for effective economic control of weed growth.

Crop rotation is valuable from many points of view, and not the least important is the influence on weed populations. It is common experience that land, freshly cultivated after being under grass sod for several years, develops less weed growth, and requires less inter-row cultivation. The weeds die more easily after cultivation because the friable soil falls away more readily from the weed roots than is the case in old cultivations. The need for laying down land to a sod grass crop for several years at regular intervals to improve soil structure, has been recognised for a long time, and it is obvious that in many of our sugar lands such a rotation must receive attention in the future.

Good ploughing is necessary for the burial and destruction of weed growth, especially of deep-rooted weeds, and for the preparation of a mellow seed bed to facilitate row planting and inter-row cultivation. In soils deficient in humus, good ploughing is particularly important for the creation of good planting tilth. The soil granulating effects of ploughing are temporary and tend to disappear under the compacting and hammering influence of rain-drops, hence the seed bed must be worked after rains, especially in soils which are normally poorly structured. Various types of implements, including the disc harrow and grubber, are used to work down the seed bed, check weed growth and prevent re-seeding of weeds. A matter for some debate is whether rotary tillage is more efficient than ordinary methods or *vice versa*. No experiments of this nature have been carried out to date in Queensland cane fields, but it is of interest to note experimental results obtained at Rothamsted. In general, yield results with several crops did not differ greatly with the various forms of tillage, but germination of seed and early plant growth were better in the rotary tilled plots. However, as the season advanced the tilth in these plots became less favourable to plant growth, the effect being more obvious in some crops than others. It was believed that the initial growth response was due to the loose tilth produced by rotary tillage, but later, setting and compaction of the soil became more pronounced in the rotary tilled plots and checked growth.

The ideal preparation of a seed bed requires cultivation on each occasion after rain has stimulated germination of weed seeds. Thus the land is kept in good tilth and the weed seed population in the surface layer of soil is practically exhausted prior to planting and the young crop is then subjected to less competition from weeds for soil moisture and plant nutrients. Cultivation is best carried out when the soil is not too wet and not too dry. The proper time to cultivate a field is not always easy to define exactly, because most fields do not dry out at the same rate and while certain patches are ready for cultivation, others are too wet. Cultivation should be carried out when the weeds are young and their root systems have not developed to any great extent. Large plants of weeds such as summer grass and pigweed often survive ordinary methods of cultivation and are able to root and grow again. However, weather conditions are not always suitable for best cultivation results and at times excessive weed growth worries even the most efficient farmer.

The labour devoted to hand hoeing of weeds in cane fields is decreasing and will obviously become less and less in the future. The use of horse-drawn implements and, more recently, tractor-driven equipment, has provided easier methods of dealing with inter-row weeds. It is not difficult to forecast that the employment of high clearance tractors with attachable fittings will expand rapidly and eventually crop cultivation will be completely mechanised.

The soil erosion factor in regard to inter-row cultivation for weed control should be seriously considered by all farmers. Cultivation on the contour reduces erosion because little channels are not left down slopes between the rows. Such channels often serve as conductors for excess water and may eventually erode into large gutters. Little or no cane planting in Queensland is done on the contour, but there are a number of areas where contour planting is possible and practicable. In addition, cultivation on gently sloping contours can be more efficient and less power is required than where cultivation up and down the slope is practised.

A form of weed control which may merit investigation is the interplanting of legumes in the row interspaces of young plant and ratoon cane for the smothering out of weeds and the reduction of soil losses. The objective would be to use a legume such as Poona pea to smother weeds during early cane growth; later when the cane covers in, the pea vines would die and lie on the surface. Obvious drawbacks are the competition between the legume and cane for soil moisture and plant nutrients and the nuisance value at harvesting from the growth of volunteer legume plants. Possible advantages would be the reduction in the number of cultivations and better retention of top soil during heavy rains, while the legume vines would add nitrogen and some organic matter to the soil, which would be available for the maintenance of cane growth during the latter part of the growing season.

Other Effects of Cultivation for Weed Control.

One of the main objects of cultivating the soil is the suppression of weed growth, but there is a widely held belief among farmers that the creation and maintenance of a shallow, loose, dry soil mulch on the surface by frequent cultivations conserves moisture, apart from the benefits of weed control. It is appropriate, therefore, to examine here

some of the effects which cultivation for weed control may have on the soil. These effects are not as well understood as they might be, and much investigation is required yet to elucidate certain aspects.

The need for weed control is obvious. Weeds take moisture and plant nutrients from the soil which would otherwise be available to the crop. This is particularly noticeable in the luxuriant growth of weeds which follows rain on ground previously treated with surface dressings of fertilizer. If weeds are allowed to grow unchecked, they spread rapidly and choke the cane as well as interfere with its harvest.

Many practical farmers and agricultural workers have held the belief that the loose soil formed by surface cultivation acts as a mulch which reduces evaporation of moisture from the underlying moist soil by keeping it at a lower temperature and preventing the capillary rise of moisture. Evidence on the subject is conflicting and a great deal of investigational work has failed to give a clear picture as to the value of cultivation for conserving moisture under varying conditions and with different soil types. However, when much of this experimental work is interpreted in the light of the depth of the water table below the surface, some very interesting points are indicated. For instance, some cultivation experiments have shown that soil moisture is conserved when the water table is about six feet or less from the surface, and the deeper the mulch the better the retention of moisture in the soil. On the other hand, in experiments in drier areas with a water table deeper than six feet, the soil mulch, in itself, has been shown to be of no value in reducing the moisture loss. Actually under these conditions cultivation may only serve to dissipate moisture particularly that contributed by showers which wet only the surface soil layer.

Briefly soil scientists now hold the view that the soil mulch, by breaking the soil capillary tubes and forming a dry, loose surface mulch does not conserve soil moisture unless a temporary or permanent water table exists within six feet of the surface. If this is true for the soil types and climatic conditions of our sugar areas, the point is of importance to cane farmers, because it indicates that good seed bed preparation and cultivation in the autumn, after the summer rains in many instances have raised the water table to within six feet of the surface, may assist considerably in the retention of moisture for the benefit of the young plants. On the other hand, however, cultivation of dry soil for the sole purpose of maintaining a soil mulch during the winter, spring, and early summer months, when the water table is further than six feet away from the surface, is valueless.

The maintenance of good soil tilth in the growing crop is important. By cultivation at a suitable soil moisture, fair tilth can often be mechanically created and the soil crust which commonly forms on medium and heavy clay soils is broken. Infiltration of rain is promoted, particularly on undulating fields, by improving the porosity of the surface soil. Raindrops tend to destroy tilth and cultivation after rain is required to restore that tilth. Soils which tend to pack readily even after comparatively light rains require more cultivation than sandy loams and soils of good structure. Hence the need for good soil management to improve soil structure. The degree of permanency of granulation in the soil at planting usually determines the frequency of tillage. In general, inter-row cultivation, except when it is necessary to break up consolidation of the lower soil layers by the grubber, should not be

deeper than three inches. Excessively deep cultivation may be harmful, especially in dry weather, because the roots are torn off and plant growth is thereby retarded.

Experience has shown that cultivation of packed soils in certain instances causes a response in plant growth which does not appear to be associated with weed control or soil moisture effects. It is believed that the factor of soil aeration is implicated. The importance of this factor is far from clear, for even in compacted soils the amount of pore space in the surface layers of soil is considerable and apparently sufficient for plant growth. However, compaction does reduce pore space, particularly in medium to heavy clay soils, while aeration is improved by maintaining good tilth and so increasing the total pore space of the surface soil layer. It is probable then, that under certain conditions, improved aeration of soils by cultivation is important.

Summing up, the main services of cultivation are the killing of weeds, the creation of good tilth and possibly the conservation of soil moisture when the water table is about six feet or less from the surface of the soil. Cultivations, which are not required for weed control or breaking the surface crust, should be avoided because the disturbance and breaking of roots of the growing plant are harmful. Cultivation effects may vary on different soils and the different objectives of soil cultivation must be modified according to type of crop, season, and soil.

WEED CONTROL BY WEEDICIDES.

Cane growers do not use weedicides extensively and, on present indications, are unlikely to expand their use very greatly. Weedicides are unlikely to displace cultivation in the major role of controlling weeds, but a good weedicide could be a very useful supplementary control. In furrow irrigated areas where it is not desired to break the water furrows and then reform them, or where elimination of particular weed species is required along creek banks, fence headlands, and other places not readily accessible to cultivation implements, a cheap, effective, and reliable weedicide could be usefully employed.

Before a weedicide could take the place of implements in interrow cultivation, it would need to be capable of killing weeds normally handled by cultivation, without injuring crop plant growth. Furthermore, it would need to be easy to apply, an economic proposition, not liable to increase the fire risk to cane and preferably should not be unpleasant to handle or toxic to the operator. Spray weedicides usually require that a considerable amount of suitable water be available. A disadvantage also is that under showery conditions, when normal cultivation implements can often be used, a weedicide application may be diluted or washed off so completely as to render it ineffective. On the other hand, however, an effective weedicide would eliminate unnecessary pulverisation of the soil and disturbance and injury to surface roots. Weeds along the row close to the plants could also be controlled. The weed residues would be left on the surface of the soil to rot down and form a layer of organic matter to assist rain penetration and reduce soil washing. However, where the structure of the soil has greatly deteriorated, particularly on undulating medium to heavy clay soils, it is improbable that weedicides would be a substitute for cultivation which is required to break the surface crust and open up the soil.

It is not intended here to discuss the wide range of materials which have been tried as weedicides, but to discuss briefly a group of new selective weedicides which have received publicity in recent years. These are the synthetic hormone type of selective weedicide. The most commonly employed of these chemicals are 2, 4-dichlorophenoxyacetic acid and salts or esters of this acid. They may be used as dusts or sprays, are non-poisonous, non-inflammable, and not unpleasant to use. On susceptible weeds they cause twisting and contortion of stems and leaves. Stems may thicken and split, the leaves discolour and finally the plant dies. Effects may be seen in twelve hours or so, but death may take several weeks. One or several applications at three- to four-weekly intervals may be required to cause complete death.

These selective weedicides do not cause appreciable harm to plants belonging to the grass family. While this would be advantageous in that cane would not be harmed, it is unfortunate that most of our serious cane weeds, such as summer grass, belong to the same group, and would also be little affected. Hence on present indications 2, 4-dichlorophenoxyacetic acid and its derivatives are unlikely to play a very prominent part in weed control in cane cultivations in Queensland.

The Bureau of Sugar Experiment Stations intends to carry out spraying and dusting trials with this type of weedicide, using a number of different weed species as test plants, and the results will be made available later. Control of weeds such as goat weed, Star of Bethlehem (*Ipomaea Quamoclit*) and volunteer legumes in the cane rows offer scope for the use of hormone type sprays. At present a limited number of farmers in the Nambour area spray the inter-row spaces with an arsenical spray for the control of goat weed. Hormone type sprays, if equally satisfactory, would be an acceptable substitute for the poisonous arsenical solution. The former type is also claimed to cause a temporary soil sterilisation after application, and it is hoped that in addition to killing the plants, germination of goat weed seed will also be prevented or delayed for some weeks. Experiments already conducted in Louisiana have indicated that control of susceptible weeds in the cane row by selective weedicides increased cane yields. In exploratory trials at Meringa results with Noogoora burr (*Xanthium pungens*), goat weed, and several other weed species were promising, and further trials are to be carried out.

FLAME CULTIVATION.

The destruction or checking of weeds and undergrowth by flame throwers has been practised for a number of years, and most farmers are familiar with the common knapsack equipment used for this purpose. The application of flame for inter-row cultivation of crops, however, is of recent origin. Like many other improvements in farm machinery, flame cultivation is aimed at the reduction of the amount of labour required on the farm, as well as giving more effective control of weeds.

It is based on the principle of selective burning, whereby the young weed growth is destroyed by a flame without seriously injuring the crop plants. The method has been used with success in cane and cotton fields in the U.S.A., particularly in the destruction of weeds in the row. Fallow flaming has also been practised. A brief description of the two main types of machine in common use in Louisiana is given

in the October, 1946, issue of the *Cane Growers' Quarterly Bulletin* in an article "The Sugar Industries of Louisiana, Cuba, and Hawaii, with Particular Reference to Mechanical Harvesting and Loading," by E. R. Behne.

Among the advantages claimed for flame cultivation are that it can be used effectively at night, and when the ground is too wet for hand hoeing; the root system is not damaged as with implements; many insects are killed and erosion is reduced by the dead weed residue left on the surface of the soil. In cane fields in Louisiana it is also claimed to improve suckering of the cane and to increase yields. Although cane is comparatively fire resistant the young plant cane does suffer some scorch and there is a possibility that early flaming has a slight adverse influence on the sugar content of the mature crop.

Since no experimental work has been carried out yet in Queensland, no data are available on the economics and efficacy of the flaming machine for use in cane fields. The necessary equipment should not be costly but the fuel item will be important. The cost of the latter will depend on the frequency with which fields will have to be flamed to secure effective weed control. Indications are that to keep a satisfactory check on weed growth weekly use of the flaming machine would be necessary particularly with the more troublesome weeds such as nut grass and the grass weeds.

Fiji Disease Control By Resistant Varieties.

By NORMAN J. KING.

THE prevalence of Fiji disease in South Queensland cane areas is well known and the history of its introduction to this State and the known methods of spread have been discussed in this journal previously. (Vol. 1, p. 20, Vol. 13, p. 1, Vol. 4, p. 12). Briefly, Fiji disease is a virus and its spread is caused either by planting setts from diseased stools or by the activity of the sugar cane leaf hopper.*

Control of the disease now presents more problems than it did formerly, and this is due to several reasons. Firstly, a greater proportion of the varieties being grown years ago, were less vigorous than present day varieties, and were relatively resistant to the disease, hence spread was not particularly serious except in the more susceptible canes such as M.1900 Seedling and D.1135. The advent of the newer Fiji disease susceptible varieties, particularly P.O.J.2878 and P.O.J.2725, and their immediate rise to popularity created conditions far more favourable for the spread of the Fiji virus, since they occupied a much greater proportion of cane land than was previously planted to M.1900 Seedling and D.1135. Secondly, the breeding of leaf hoppers has been favoured during the past decade or more, by increased irrigation throughout many of the areas that previously depended solely on natural rainfall. It has been shown that leaf hopper populations in canefields increase in proportion to the succulence of the crops, and it follows that if infection

* *Perkinsiella saccharicida* Kirk.

is present, spread of disease on irrigated farms will be more serious than in non-irrigated farms by virtue of the increased numbers of leaf hoppers on the former. Practical experience over the years has further confirmed this fact, and it is well known that, once established, Fiji disease spreads most rapidly on irrigated or alluvial soil farms where growth is usually prolific. Thirdly, the variety P.O.J.2878 has proved an ideal cane for standing over, in consequence of which the proportion of standover cane has increased. Infected standover fields cannot be rogued effectively and this means that diseased stools of standover cane remain as a source of infection for young cane for a much longer period than if the farm programme were limited to the growing and harvesting of twelve to fourteen months old crops.

The problem of controlling this diesase which is of paramount importance is thus more complicated than previously. The existence of any major disease in a district limits the varieties which can be grown there and has a definite bearing on the success of the Bureau seedling selection work. Every year many desirable canes have to be discarded because of their susceptibility to some major district disease.

Control of disease has become one of the main functions of the local Cane Pest and Disease Control Boards. These Boards employ a supervisor and a gang of inspectors trained to detect specific diseases, and they inspect all fields in the area and dig out diseased stools. Such a measure has a very desirable control value, inasmuch as each stool removed is one less focus of spread, but it has the disadvantage of always being a step behind. It is obvious that by the time the stool is detected and destroyed leaf hoppers have probably spread the infection to other stools, and symptoms in these are not recognisable for a certain period—sometimes many months—during which. outward symptoms remain dormant. Combined with plough-out and harvest orders, this method of control does good work, but it rarely happens that a farm or sub-district is completely cleaned up by this means. In the Isis Mill area, where Fiji disease appears to have been reduced almost to vanishing point, the above measures have been combined with a very rigid control of planting material. However, control there has been assisted by the fact that climatic conditions in the Isis Mill area are not generally favourable for the rapid spread of the disease, and this has particularly been the case during the past few dry years.

By far the best control, although a drastic one, is that exercised by the growing of resistant varieties only. South Queensland has an outstanding example of this method and it is proposed to discuss this as exemplifying the success which can be achieved in a relatively short space of time.

The Fiji disease susceptible, high-numbered P.O.J. canes were distributed to local growers between 1933 and 1936, and Q.25, also very susceptible, in 1940. Fiji disease was scattered throughout the area and was the cause of some concern, but after 1940 the threat to the varieties being grown became more pronounced. On some of the best alluvial soils P.O.J.2878, P.O.J.2725 and Q.25 were the major varieties planted and it was soon realised that Fiji disease was not being adequately controlled by periodic digging out of stools or by plough-out orders. Some idea of the position may be obtained from the figures of acreage and stools found. Two major infected areas existed at Avondale and Tantitha. In all, the gross assigned acreage approximated 800 acres. In

the year 1941-42, 1,875 stools were destroyed; in 1942-43, 1,500 stools; in 1943-44, 4,091 stools, and in 1944-45, 5,264 stools. During this period, some resistant varieties, principally Co.290, were being planted so the number of diseased stools per acre of susceptible varieties was worse than the figures indicate.

During the year 1943-44 a quarantine was created in these two areas, under which the growing of the three above-mentioned varieties was prohibited. Farmers within the quarantine areas were able to grow to second ratoons any cane planted prior to the establishment of the quarantine, providing the severity of the disease did not justify a plough-out order prior to completing the crop cycle. It was not until 1946 therefore, that all susceptible varieties disappeared from those areas. Replacement canes, with a degree of commercial resistance to Fiji disease were distributed in the interim and the majority of this quarantine area is now planted with C.P. 29/116, Q.42, Q.47, Q.48, Q.49 and Co. 290; Q.28 and Atlas also occupy small areas. The result of the quarantine and the varietal change is shown in the following table:—

Year.	No. Fiji stools Eradicated.
1941-42	1,875
1942-43	1,500
1943-44	4,091
1944-45	5,264
1945-46	231
1946-47 (10 mths.)	96

With the exercise of normal precautions in plant selection, the Fiji disease menace should completely disappear from these areas within the cycle of the existing crops, provided careful inspections are continued. To reduce disease incidence from over 5,000 stools to less than 100 in two years is a creditable performance and the major part of this credit is due to the use of commercially resistant varieties.

This is not the only example of Fiji disease control by varieties. The most heavily infected area in Queensland, the Island Plantation at Maryborough, has now been free of Fiji disease for over four years and the planting of the susceptible M.1900 seedling is again allowed. As more disease resistant canes become available, there is little doubt that other major diseases will suffer a like fate. Downy mildew in Bundaberg is being markedly reduced by the widespread planting of C.P.29/116 and Q.49 and, of course, gumming disease is a thing of the past in the whole of South Queensland since the elimination of susceptible canes.

It is unfortunate that Fiji disease has continued to spread in the areas which were not quarantined. Satisfactory control will never be attained while large areas of susceptible varieties are grown, particularly where crops are irrigated, and it is hoped that at least 50 per cent. of these lands will be planted with resistant varieties in the next two years. The performance of Q.47 and Q.49 demonstrates that they are worthy competitors of the susceptible P.O.J. varieties and have the added advantage of commercial resistance to Fiji disease.

The Symptoms of Leaf Scald Disease in Sugar Cane.*

By C. G. HUGHES.

Introduction.

LEAF scald disease is one of the diseases which occur in cane crops in North Queensland. Previously, when the bulk of varieties grown possessed a fair degree of resistance, this disease was not directly a cause of severe losses. However, with the change in varietal position in recent years, leaf scald has assumed a new importance. In view of the fact that two of the new varieties—Q.44 and Trojan—can easily become infected with this disease, a general description of these symptoms might be of considerable help to farmers in identifying it should it occur in their own crops. In addition, a knowledge of symptoms will assist in the appreciation and understanding of the paper contributed to these Proceedings by Mr. P. Volp, describing his efforts to obtain healthy planting material from diseased fields. (Reprinted on p. 36.)

Like very many other diseases affecting plants and animals, and humans, too, leaf scald is caused by a particular germ. In this instance it is a small bacterium which, as far as is known, cannot live in the soil, so that any infection of healthy plants must come from previously diseased stools. The bacteria may gain entry to a healthy stool when it is cut by cane knives which, through cutting diseased sticks, have the disease bacteria in the juice smeared on the blade; where a fresh stalk is cut some of the old juice with the organisms remains on the stubble and so may infect the stool. Setts may similarly become infected. Spread may also occur from one plant to another through the bacteria in a diseased plant finding their way onto the surface of leaves and so being transferred, probably by insects or wind-blown rain, to neighbouring plants. Diseased stools will, of course, also result from the planting of diseased setts. The bacteria grow and multiply within the tissues of the host plant, living entirely as parasites, upsetting the balanced life of the plant, and contributing nothing in return. Because the major damage to the plant occurs through infection in the vascular tissues, or veins, as they are commonly termed, leaf scald is placed in the group of vascular diseases. The harm done by the parasitic bacteria depends on the reaction of the host; if it is resistant to their attack the bacteria will cause very little damage and there may be no external evidence of their presence; on the other hand, if the variety is very susceptible the bacterial activity may result in the death of the infected stool. Between these two extremes lie the symptoms characteristic of the disease.

External Symptoms.

External symptoms of the disease occur in two distinct phases: a chronic form when the plant shows obvious symptoms and persists for an indefinite time in a state of ill-health, and an acute form when the plant suddenly wilts and dies. The two forms are so different in appearance that they were at first regarded as belonging to two separate diseases. Either form frequently occurs to the exclusion of the other, but often they grade into each other.

* Paper presented at the Innisfail Conference, Q.S.S.C.T., May, 1947.

The Chronic Phase.—In the chronic form, the one really typical diagnostic feature of the disease shows in the streaks on the leaves. These are straight, narrow, well-defined streaks following exactly the veins of the leaf-blades. They are usually quite white in colour, although sometimes they may be a very pale yellow or grey, and are very regular in outline. They look for all the world as though ruled along a straight-edge and are often referred to as "pencil lines." They may pass down onto the leaf sheath, where they often assume a purplish tinge, and can be seen on the youngest leaves. The streaks vary in length from very short to the full length of the blade and sheath. Older streaks tend to broaden and become diffuse as the effects of the death of the whitened vein are felt on the tissues of the leaf, and irregular, reddish areas may develop. The broadening of the streaks and the loss of the sharply defined margin are followed by withering and death of the tissue. Sometimes the irregular outline and withering may develop in the middle portion of a streak but usually they commence near the edge of the blade, proceeding inwards towards the base of the leaf as the streak ages.

The most typical picture of a well-developed streak is a white pencil line, well defined and regular in the lower part, broadening out as it goes upward, and running to the leaf margin in a wide area of dead leaf blade. The withering and death of the edges and tip of the leaves give to the plant the "scalded" appearance, from which the name of the disease is derived. The damage to the leaf tissues also leads to an upward curving of the blade and when several leaves on the one stalk show well-developed streaks the inarching leaves gives a general effect not duplicated in any other cane disease. Enlargement of the streaks is much more rapid in dry than in wet weather and when the cane is growing vigorously the narrow, white, inconspicuous lines are the only symptoms to be found. Another prominent feature of the chronic form is the production of side shoots by diseased canes, usually after the upward growth of the cane has slowed down or ceased. Quite often every single bud both above and below ground produces a shoot. They are usually weak and thin and display symptoms resembling those on the main leaves; pencil lines on both blade and sheath are usually very pronounced. The side shoots are often of great value for diagnostic purposes, particularly when symptoms on other parts of the plant have been obscured by withering or when a stool dies from the acute form of the diseases (*q.v.* below). Another symptom which may occur on either side shoots or tops is a pronounced chlorosis of the leaves. *Chlorosis* is a term used in describing a part of a plant which, although normally green in colour, has for any reason failed to develop any colour. With leaf scald the chlorosis may extend over the whole area of the blade and may involve several leaves in the one shoot. It may be seen at any stage of the chronic phase but is very common in young shoots coming away from diseased plants or diseased ratoon stools. Occasionally, if growing conditions are very good, the stalk may throw off, or may grow out of, the chlorosis and later the old chlorotic leaves may be observed below a normal green top; usually, however, the shoot does not recover from the chlorosis and the leaves wither and inarch and the shoot dies.

The Acute Phase.—In the acute phase of leaf scald disease the affected plants wilt suddenly and die for no apparent reason. The effect is just as though all the roots had been cut. The leaves wither, then the stalks shrivel and dry out. Sometimes the death of the stool

occurs very quickly and, on occasions, less than a fortnight will see the change from a vigorous growing stool into dead trash, with not a trace of green. Such rapid wilting, however, occurs only in the driest weather and usually the process is much more prolonged. The wilting commonly involves the whole stool, but sometimes only part may be affected with the remainder growing perfectly normally. The wilting may be in patches in a field but usually it shows in scattered, individual stools. It is most pronounced in the drier seasons, particularly if a period of continuous dry weather occurs during what should be the best growing period of the year. It is most common during the latter part of the crop's growth. This acute form is fairly common in North Queensland, varying in amount from season to season, and many a dead stool, apparently normal at a cursory inspection, has died as a result of leaf scald attack. It is often difficult to make a positive diagnosis of scald, but in many instances a careful search will reveal small shoots at the base of the stool showing streaks characteristic of the chronic phase. If there are no such shoots they often appear when the stool is cut down and ratooned.

Internal Symptoms.

Internal symptoms of leaf scald consist chiefly of fine, red streaks seen when the diseased canes are split lengthwise. Actually these streaks, looking much like short pieces of red cotton, are discoloured veins, or vascular bundles, and correspond to the white, diseased veins in the leaves. Most of the reddened bundles are seen at the node—that is, the region of the stem at the level of the bud—since the veins there follow tortuous, mostly horizontal courses, quite different from the straight, vertical paths in the juicy pith between the nodes. These reddened bundles may be seen right up into the growing point at the top of the stem as well as in any diseased side-buds. Usually, there is some association of the reddened bundles, with the amount of streaking or chlorosis visible externally on the leaves, the more streaking there is the more internal reddened bundles. Sticks which have died from the acute form of the disease, unless there be diseased shoots at the base, will not show any reddened vascular bundles.

Conclusion.

Briefly recapitulating the symptoms of leaf scald disease, the following may be emphasised:—

The Chronic Form.

(*a*) Characteristic streaks with white pencil lines along the leaf veins and expanded withered parts towards the edges of the leaves;
(*b*) Side shoots;
(*c*) Chlorosis and inarching of the leaves;
(*d*) Reddened vascular bundles within the stem.

The Acute Form.

(*a*) Unexplained dead stools in an apparently healthy crop;
(*b*) Occasional small diseased shoots at the base of the diseased stools.

Usually, leaf scald is a minor disease, but like many others in the same classification it can on occasions cause considerable losses and indirectly can be very important, as when its presence prohibits the

release of a susceptible but otherwise very desirable new cane. In North Queensland, leaf scald can usually be found on any of the wetter, richer lands but Badila is comparatively resistant to the disease and suffers little loss. S.J.4 is more susceptible but is kept reasonably clean by virtue of the fact that when stools of that variety contract the disease they normally die and so there is no widespread diffusion of the disease through the paddock as the crop cycle is advanced. However, two of the newcomers, Trojan and Q.44, are susceptible to the disease and will have to be watched carefully. Already leaf scald has been found in these canes and the outbreak in Trojan in the Victoria Mill Area in 1945 was reported by the Chairman of the Victoria Cane Pest and Disease Control Board to have involved over 1,000 acres with an estimated loss of over 2,000 tons of cane. Only the promptness of the Board in applying control measures prevented much greater losses.

The Ineffectiveness of Roguing Leaf Scald Infected Fields for Use as a Source of Planting Material.*

By P. VOLP.

LEAF scald is a bacterial disease and its presence in a field may be due to the use of diseased planting material; alternatively, it may be due to spread from an adjacent diseased field either by mechanical means such as the use of infected knives or by some form of natural transmission such as infected insects. Since diseased planting material is the most common cause of spread of the disease, one essential method of control to be adopted by growers is the use of clean seed.

Many varieties including Badila, Q.10, Q.44, Clark's Seedling, S.J.4, and Oramboo vary in their degree of resistance to leaf scald according to the locality in which they are grown, a fact no doubt governed largely by climatic and seasonal conditions. Variation in seasonal conditions affects the growth of the cane plant. With favourable soil moisture the plant makes a vigorous growth and is often better able to overcome the effects of harmful bacteria. On the other hand, if harsh growing conditions prevail, the plant's system may be so weakened by its uphill fight to maintain life that it readily succumbs to disease in the early stages of its growth. In varieties such as Q.44, S.J.4, and Badila, symptoms of leaf scald are often difficult to find during the early life of the cane, provided it is growing in a favourable environment. Symptoms, however, become more obvious during the late spring and early summer when drier weather usually prevails in northern sugar districts.

All varieties, prior to their release to the industry for general planting, are tested by the Bureau of Sugar Experiment Stations to ascertain their degree of susceptibility to leaf scald. (This testing applies to all the major diseases which affect the sugar-cane plant in Queensland.) Whilst some varieties prove so susceptible to disease in these trials that they are not approved for general planting, there are many instances where the susceptibility of a variety is no greater than that of many

* Paper presented at the Innisfail Conference, Q.S.S.C.T., May, 1947.

other varieties already on approved lists. Should such a variety have outstanding agricultural qualities a moderate susceptibility to leaf scald would not prevent it from being approved for planting, but, as far as possible, the variety should be restricted to those areas where leaf scald is not a serious problem. The results of disease resistance trials, so far as commercial varieties are concerned, are passed on to the grower per medium of Field Officers, Disease and Pest Board Officers, and publications in the various sugar journals. From the leaf scald resistance trials, canes are classified as resistant, moderately resistant, moderately susceptible, or susceptible to this disease, together with a note as to tolerance. Oramboo and Clark's Seedling are examples of susceptible varieties which succumb readily to leaf scald even when growing under favourable conditions. Moderately susceptible varieties —*e.g.*, Q.44—may show an occasional symptom in early growth stages but a heavy infection in the late spring and summer, especially when the soil moisture is poor. Fields of varieties of this type, which show few, if any, symptoms of leaf scald under good growing conditions generally do not suffer serious damage unless an unfavourable season occurs. Unfortunately, the fact that the disease symptoms frequently do not show up in diseased stools of tolerant varieties when growth is good makes the problem of securing disease free plants a more difficult one. Particularly is this so when seed for early planting is required, since at that period many diseased fields of a tolerant variety might appear clean on inspection.

As most growers are aware, the loss in tonnage and sugar content due to disease is greatly increased by the use of diseased planting material. There are occasions, however, when owing to a scarcity of planting material from approved sources growers are obliged to select plants from fields which are known to be infected with leaf scald. Such a scarcity, brought about by the ravages of floods, drought, and heavy grub infestation led the writer to attempt roguing diseased stools from fields or sections of fields which were to be used as a source of planting material. This was undertaken in order to prevent as far as possible the wholesale planting of known diseased material.

It is the writer's custom to inspect all fields in the area under his control at least three times during the growth of the cane. On these inspections all fields are noted as being either diseased, under suspicion, or apparently clean. During the course of this work it was noted that leaf scald disease in the variety Q.44, as with other varieties, was more prevalent in those sections of the Mulgrave area which receive the greatest rainfall. These observations indicated that with this variety distribution of the disease was largely governed by climatic conditions. Fields chosen as a source of plants were inspected row by row and all stools showing signs of leaf scald were chopped down before the plant cutters commenced operations. Normal precautions of disinfection were carried out on both cane knives and cutter-planter blades. Five sections of plant fields in the wetter section of the area were rogued during May and two further sections in August. Blocks chosen were those which it was considered would yield suitable planting material, and they would have averaged 30 tons per acre or over. These were previously classed as under suspicion. In addition, two second ratoon blocks were selected from which diseased stools had been rogued in previous years. The fields "under suspicion" were planted in 1945 with disease-free material,

but as leaf scald was well established in adjoining blocks it was considered quite probable that natural spread had occurred and, therefore, the plant crop was suspect as a source of planting material.

In the plant fields which were rogued, the number of diseased stools destroyed ranged from nil to 16 and in the two ratoon blocks there were 14 and 78 stools destroyed, respectively.

An inspection of the planted fields from one to two months after germination revealed the presence of leaf scald in all the blocks planted from the rogued cane even though no symptoms were discernible at the time of planting. The percentage of infected stools varied from 0·01 to 2 in the fields planted from plant cane and from 2 to 6 in the fields planted from ratoon material. The first three of the fields inspected in May did not show any signs of the disease in the section from which the plants were inspected, but a re-survey of the standing sections of plant cane showed 1 per cent. diseased stools in July and up to 5 per cent. in early September. By that time severe wilting of the stools or death had taken place. (This indicates how the degree of resistance of a variety to leaf scald may vary according to the weather conditions. In the spring and early summer it is usually comparatively dry and often very dry, whereas earlier in the year conditions are moist to very wet.) The two fields planted from the plots rogued in August where 11 and 16 stools were destroyed, respectively, have shown to date (December, 1946) the same percentage of young diseased plants as the earlier planted plots. A survey during October, 1946, of the young first ratoon field which had registered 5 per cent. death of stools in September showed the infection to be as high as 30 per cent. in the young ratoons, and this in a field originally planted with apparently clean seed.

From the writer's experience, then, the roguing of varieties which are moderately susceptible to leaf scald gives no assurance of clean seed when the varieties are infected and conditions are favourable for plant growth. As a means of control for this disease, roguing should only be regarded as a last resort in an attempt to keep within reasonable bounds the infection in subsequent plantings. The periodical introduction of clean seed to a diseased farm in a wet area at comparatively long intervals is also not a successful control measure, since considerable natural spread apparently takes place at some stage of the plant's growth. The only effective means of control appears to be the introduction of clean seed for every planting made on an infected farm, and in no circumstances should any cane from that farm be used for planting—even for supplies. As an additional measure of security, all cutting implements must be disinfected before use, particularly when being transferred from field to field.

The observations recorded above have particular reference to the effect of leaf scald on the variety Q.44 in the wet section of the Mulgrave area during 1946. In the dry portion of the Mulgrave area this year no signs of leaf scald have been observed in this variety, and in this sugar district, at least, the distribution of the disease appears to depend largely on the local climate. The writer intends at a later date to ascertain the monetary loss from crops badly infected with the leaf scald, and, with this end in view, figures are now being collected for future reference.

Meeting of the Sugar Experiment Stations Advisory Board.

The Sugar Experiment Stations Advisory Board met in the office of the Innisfail District Cane Growers' Executive, Innisfail, on Tuesday, 29th April. There were present the Hon. H. H. Collins (Minister for Agriculture and Stock and Chairman), Messrs. J. W. Inverarity and J. C. Collier (Millers' Representatives), W. L. Poustie and L. G. Scotney (Growers' Representatives), A. F. Bell, and E. R. Behne (Bureau of Sugar Experiment Stations). This was the first meeting of the new Board, which was elected to office earlier in April, the new members being Messrs. Collier, Poustie, and Scotney. Mr. Inverarity was re-elected to the position of Deputy Chairman.

The business dealt with was mostly formal and included consideration of the financial estimates for the year 1947-48 and the rate of levy for that year—the maximum rate allowable under the Act, one penny per ton of cane, being recommended. In this regard the Board felt that with the increasing activities of the Bureau, it would be necessary to provide for a higher rate of levy and accordingly submitted a recommendation to the Minister that the Act be amended to permit of a total levy up to threepence per ton of cane.

Following the amendment of the Act to empower Cane Pest and Disease Control Boards to subsidise growers within their areas, the Powers and Duties of these Boards were re-drafted and a comprehensive set of such Powers covering all Boards was adopted.

The Deputy Chairman (Mr. Inverarity) reported the existence of an area of land which might prove a satisfactory site for the proposed Experiment Station in the Burdekin. The Board decided that this site be investigated immediately by the Soils Chemist, with the recommendation that, should it be suitable, negotiations for its purchase be commenced.

Again members expressed concern at the continued failure to fill important vacancies in the Bureau staff, with particular reference to that of Plant Breeder. It was recommended that applications be called for this important duty throughout Australia, and overseas if necessary.

An important decision made was that field days be held at the Meringa and Mackay Sugar Experiment Stations this year. Certain changes in the method of conducting these field days were adopted with a view to the visitors obtaining a more satisfactory demonstration of the work in progress at the Stations. It was decided that field days would be held at Mackay on 18th June, and at Meringa on 20th June.

Other matters dealt with included routine Pest Board matters, disapproved varieties, and field equipment.

Mechanical Fertilizing.

By S. O. SKINNER.

THE mechanisation of general cultivation work on the cane farm has progressed rapidly in recent years by the use of fast light tractors and their attachments, but it is somewhat surprising that similar progress has not occurred with the mechanisation of fertilizer distribution.

Most growers appreciate that hand spreading and vibrator methods are slow and laborious, as well as comparatively costly, and some have devised various attachments for their speedy tractors for particular fertilizing work, thereby making a satisfactory saving of labour. It is considered, however, that there is much scope for local or larger implement manufacturers to design an all-purpose distributor that could be used in conjunction with planting, cultivating and ratooning. In this connection, it is interesting to record the performance of an attachment purchased last year by Mr. A. G. E. Hansen, of the Qunaba Mill Area, from which most encouraging results have been obtained.

FIG. 5.—Side view of fertilizer attachment, showing chain drive from rear wheel, and arrangement of hose outlets on cultivator tyne.

The two photographs Figs. 5 and 6 show the distributor, which is one of the normal attachments for such tractors for vegetable cultivation. Two bins, each of approximately two kerosene tins in capacity, fit beside the fuel tank. Feeding from both containers is performed by internal cogs which are operated by a link chain and sprocket from off the rear wheel. Both bins have two chutes with flexible metal hoses which lead down to ground level. Normally, the hose outlets are attached behind tynes or similar cultivating tools.

The fertilizer is cut off at the end of drills by a dog clutch which automatically throws the gearing out with the pneumatic lifting of the tilling attachments. Rate of application can be adjusted from 60 to 600 lbs. per acre.

As indicated later, the grower has used the attachment in conjunction with practically all tractor operations. Its only limitation appears to be in the application of fertilizer to the drills during planting, where the furrows are opened by the planter itself. In this case, the extension of the flexible hoses to the planter at the back of the tractor does not allow sufficient fall for the fertilizer to flow after it leaves the bins. This limitation, however, is somewhat offset by the fact that cane planters are made usually with a special distributor for the purpose. However, the distributor on the cane planter cannot be employed independently

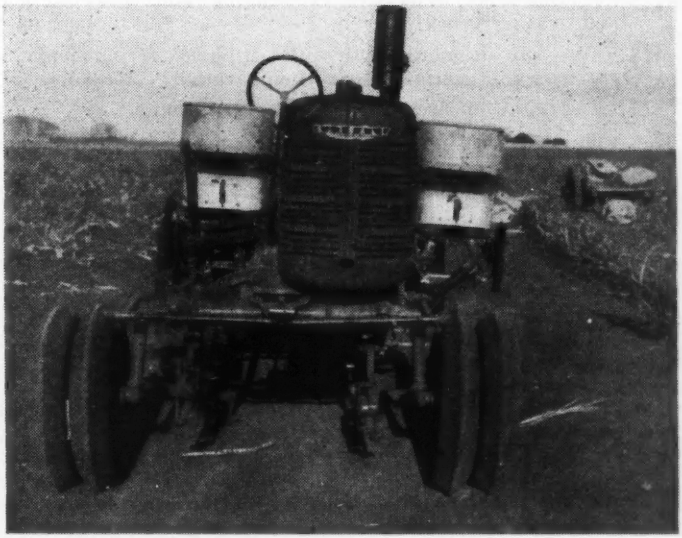

FIG. 6.—Front view of fertilizer attachment on tractor.

for later work, and the need for a further machine still exists. An improvement in the distributor illustrated would be a modification whereby the fertilizer attachment could be placed further back. This would eliminate the cost of the planter distributor, and also simplify its use with grubber ratooning. In the case of the latter with the present arrangement, and with the grubber either as a rear attachment or separate implement, the flexible hoses of the distributor have to be extended to small tynes as shown in the photograph Figs. 5 and 6. This prevents deeper placement of fertilizers, which would be obtained from behind the more powerful and deeper working grubber blades.

The distributor has not performed well with lumpy fertilizer, either sulphate of ammonia or mixtures, the trouble being due mainly to small lumps clogging together in one chute and causing a stoppage. The grower, however, has found it convenient and quick to tip the bag of fertilizer, as required, from the back of his farm trailer through a seven-eighths inch round hole sieve rested on a container. It is claimed

that this cannot be regarded as extra work since in any case the weight of present sized bags of fertilizer necessitates emptying into smaller containers to allow of filling most distributing receptacles. In one instance, during a slack day, the grower tipped, broke lumps and re-bagged some of his fertilizer into convenient smaller amounts in the storage shed. This prior breaking of hard lumped bags was found to be time saving, as it made filling of the distributor later a matter of minutes only.

The attachment has been used for all fertilizing operations on the farm, including:—

(1) For planting, in the case where the drills have already been opened, by applying the fertilizer to the open drills;

(2) For grubber ratooning, by taking the hose outlets to cultivating tynes;

(3) For top dressing, both with sulphate of ammonia and mixtures, in conjunction with cultivation;

(4) For rapid top dressing, without cultivation.

The adaptability of the fertilizer distributor is shown by the following instance—From accumulated sundry fertilizer stock, the grower desired to apply two different mixtures, as well as sulphate of ammonia and potash. By means of the two separate bins and sets of hoses, it was possible to apply two different mixtures at the one time to a block of cane and the potash and sulphate of ammonia in another operation to another block.

It was found also, when top dressing with sulphate of ammonia, that a better spreading was obtained than by hand. This was achieved by leaving the end 12 inches of the hoses loose, thus allowing them to swing freely with the movement of the tractor. In operation, this action gave distribution beside and around the stools, and under leaf level, thus eliminating any possibility of burning from the sulphate of ammonia falling on tender foliage. Since the fertilizer is normally applied with this attachment when carrying out other cultural operations, the acreage fertilized per day is of the same order as that covered by the tractor when used for planting, ratooning, cultivating or grubbing, less the slight loss of time in refilling the fertilizer bins.

The excellent rate at which the combined operations of fertilizing and cultivating were carried out, when using the scarifier attachments, was even improved in some instances. For example, where thorough cultivation was not essential, tynes were spaced wider than normal and every second row was straddled. By using the four hoses, the grower was able to fertilize both sides of each straddled row and one side of the adjoining two rows, and by repeating this operation on every alternate row, all drills were fertilized on both sides. Where top dressing only was required, similar straddling of alternate rows enabled a speedy cover of the field.

The cost of the distributor was approximately £29. It is not claimed that this particular attachment is the ideal one, or that there are not other distributors of equal merit, but its performance does demonstrate very clearly, the cheapness and rapidity with which large areas can be covered. It has shown, moreover, that labour costs can be reduced and that fertilizer distribution can be a less laborious task when combined, in the manner described above, with routine cultivation work.

Soil Fertility Surveys with Particular Reference to the Garradunga Area in North Queensland.*

By C. R. VON STIEGLITZ.

Introduction.

IN 1938 a technical communication of the Bureau of Sugar Experiment Stations, by Kerr and the writer (1), described the correlation that had been obtained between responses to fertilizer in the field and laboratory methods for assessing available plantfoods. These correlations had been obtained after some nine years' work on the major soil types of the various cane-growing districts and showed that, provided adequate care was taken in sampling the soil, and this sampling confined to a definite stage in the crop cycle, it was possible to predict fairly accurately, from the soil analysis, the likely response of the crop to fertilizer in the field.

Practical Application.

Two methods of practical application of these findings suggest themselves: (1) the analysis of soil samples taken by farmers or field assistants for farmers; and (2) the institution of fertility surveys in certain selected areas. Each has certain disadvantages. For instance, in regard to the former, interpretation of the results of analysis is rendered very difficult when the samples are not taken at the prescribed time of the crop cycle and when no information is supplied concerning the past fertilizer history of the block. If, however, such samples have been taken in the prescribed manner and full details of past fertilizer history given, the farmer receives the information he seeks in the minimum of time.

Fertility surveys, as a contrast to the above system, deal intensively with a comparatively small area of one district, but the information obtained when the survey is complete can be mapped and becomes a valuable source of reference and help to the field man in whose area the survey has been made. The first fertility survey to be attempted was carried out with the cooperation of Mr. Knust in No. 6 Branch, South Johnstone.

This area is one of mixed soil types but mainly red volcanic loams and red and brown schists. The results of the first year's sampling and analysis demonstrated that the soil in many fields believed to be of volcanic origin was indeed derived from schist. Furthermore, some of the volcanic loams were found to be deficient in phosphoric acid whereas normally this type of soil is fairly well supplied with phosphates in a form available for plant assimilation. Unfortunately, it was not possible to continue with this survey owing to the quantity of mill residues, mud, and molasses which were distributed in the area on unsampled blocks after the survey started.

An area in the Garradunga district was then selected for survey and, in the first year, all fields carrying a mature plant crop or from which a plant crop had just been harvested were sampled for analysis. A similar procedure was adopted for subsequent years until practically

* Paper presented at the Bundaberg Conference, Q.S.S.C.T., April, 1946.

all blocks in the area had been sampled at the same time in the crop cycle. Although a very good idea of the general trend of fertility was obtained in the first year and farmers advised accordingly, it was of considerable interest and value to the field officer of the district to

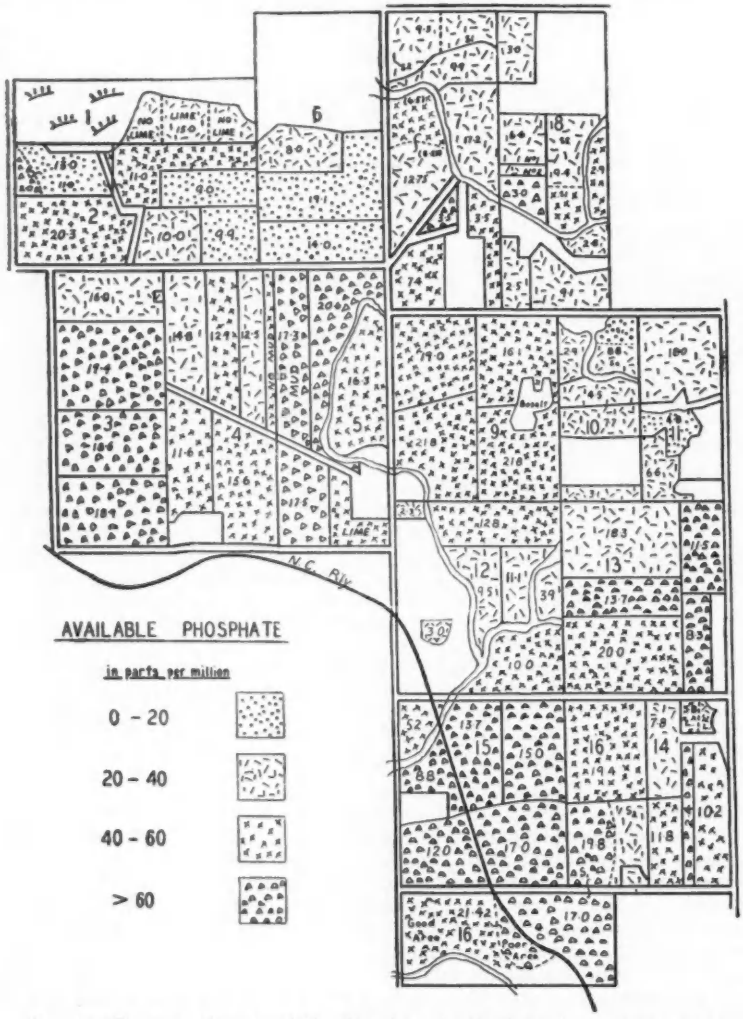

FIG. 7.—Chart showing Available Phosphate in the Garradunga survey area.

complete the sampling and to have the analysis of the whole area done so that the results could be mapped and kept as a record for reference. The routine measurements performed on all samples were pH in normal potassium chloride suspensions, available phosphate, replaceable potash, and total replaceable bases. The completed analytical results of the

Garradunga survey have been placed in certain groups and mapped as shown in Figs. 7, 8, and 9.

Discussion.

Prior to the survey the Garradunga area was thought to require a potash rich fertilizer. Sugar Bureau No. 3 or some other potash-rich mixture was that normally used and, whilst this fertilizer has been successful for most volcanic loams in the sugar areas, it has a relatively low content of phosphoric acid. The analytical results of the survey

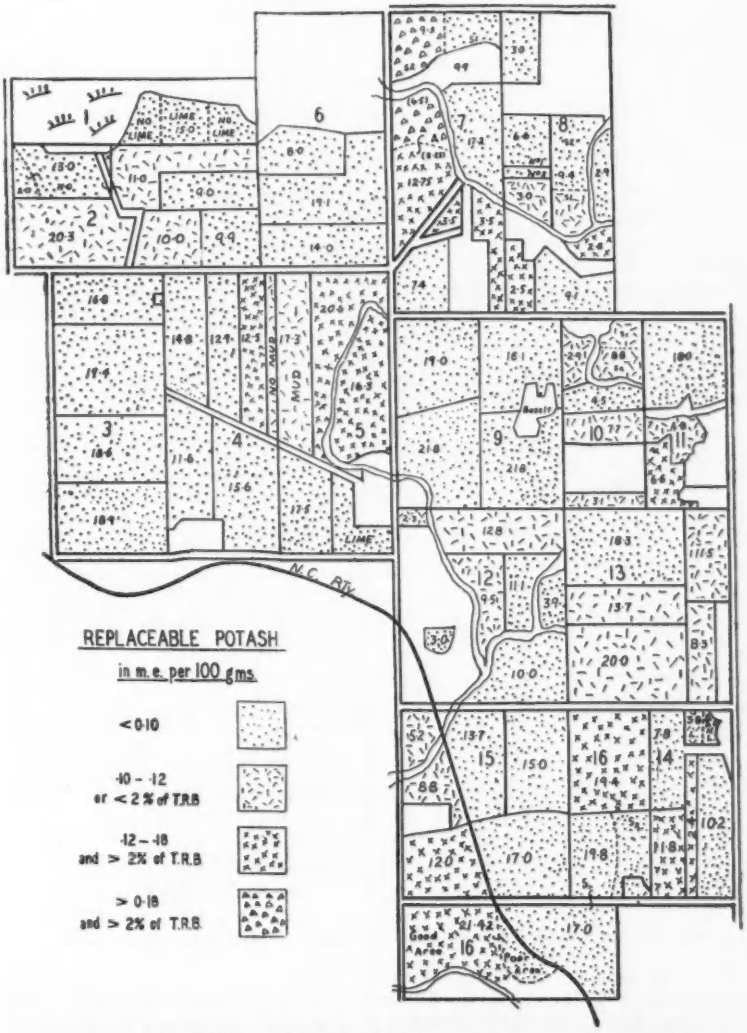

FIG. 8.—Chart showing Replaceable Potash in the Garradunga survey area.

showed very clearly that a number of the fields required a mixture rich in phosphoric acid as well as potash, so that a change to Sugar Bureau No. 2 mixtures for plant and ratoons was advised for many of the blocks. Unfortunately, about the time that this information became available, fertilizer rationing began and available supplies were not sufficient to

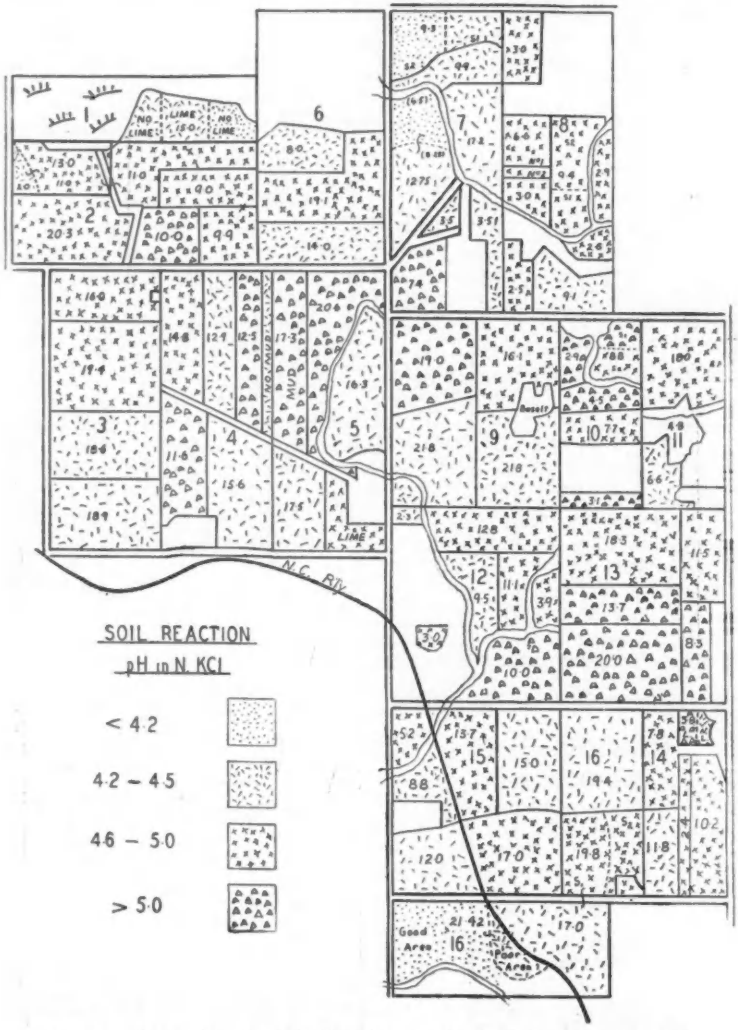

FIG. 9.—Chart showing Soil Reaction in the Garradunga survey area.

permit farmers to purchase all they wished. The information was, however, very valuable to the Bureau from a fertilizer rationing point of view, and it is felt that the fields in this area were given a more suitable mixture than they would have received if the information obtained from the survey had not been available.

It will be seen from the mapped results on Figs. 7, 8, and 9 that the majority of the area is not in need of lime to correct acidity but that certain small areas are showing up fairly acid. This is not normally encountered in our red volcanic loams and a watch will need to be kept to prevent further deterioration due to the excessive leaching encountered in this area of heavy rainfall. The figure showing the results of the phosphate tests is particularly interesting, as normally the red volcanic loams supply ample available phosphoric acid for the needs of sugar-cane. It will be seen that quite a number of the fields are low in phosphate and a few very low—the low ones having a figure of less than 40 p.p.m. available phosphate. In all such cases the use of Sugar Bureau No. 2 mixtures is recommended. As regards the available potash, it will be seen that most blocks fall into the low or very low class and, unless also low in available phosphate, will be most benefited by applications of Sugar Bureau No. 3 fertilizer mixture or by molasses.

Other Surveys.

Since the commencement of the Garradunga survey, others have been initiated in the Mourilyan, Mackay, Bundaberg, and Childers areas and, in addition to the yearly sampling of the fields, a monthly sample is taken to determine the seasonal effect on the available soil nutrients. The information already to hand from these areas is valuable and, so far as the South Kalkie area in Bundaberg is concerned, it has shown that, although these soils do not normally show a response to potash when first brought under cultivation, potash must be included in the normal fertilizer mixture in order to keep the available supplies at a reasonable level.

Summary.

The general use of fertility surveys is discussed and results from the Garradunga area in North Queensland tabulated and discussed.

Acknowledgments.

The writer wishes to acknowledge the careful soil sampling work performed by Mr. H. Knust, Adviser in Cane Culture, and the data supplied re the area of blocks, &c., also the analytical work performed by Messrs. Cassidy and Home.

REFERENCE.

(1) KERR, H. W. and VON STIEGLITZ, C. R. of Bur. of Sug. Exp. Stns. Tech. Comm. No. 9, 1938.

APPENDIX.

Criteria used for the various grades of fertility and soil reaction.

AVAILABLE PHOSPHATES.

Very Low.—All soils with less than 20 p.p.m. P_2O_5.

Low.—20–40 p.p.m. P_2O_5.

Medium.—41–60 p.p.m. P_2O_5.

High.—$>$ 60 p.p.m. P_2O_5.

AVAILABLE POTASH.

Very Low.—All soils with less than 0.10 m.e. per 100 g. replaceable K +.

Low.—0.10–0.12 m.e. per 100 g. K + or replaceable potash $<$ 2 per cent. of total replaceable bases.

Medium.—0.12–0.18 m.e. per 100 g. K + and replaceable potash >2 per cent. of total replaceable bases.

High.—Replaceable potash > 0.18 m.e. and > 2 per cent. of total replaceable bases.

SOIL REACTION IN 1N. KCl SUSPENSION.

Very strongly acid.—pH < 4.2.

Strongly acid.—pH 4.2–4.5.

Medium.—pH 4.5–5.0.

Slightly acid.—pH >5.0.

The various grades shown have been chosen to correspond largely with the results obtained in fertilizer field trials. These showed that response in the field to phosphate was rarely obtained if the available figure was greater than 40 p.p.m. P_2O_5. As regards potash, consideration must be given to the amount of other replaceable bases, but once the replaceable potash drops below 0.13 m.e. per 100 g. practically all soils respond to potash fertilization.

A New Policy in Seedling Selection.

By C. G. HUGHES.

THE raising of seedlings comprises a very large part of the work at each of the three Experiment Stations maintained by the Bureau. The crosses are made and the seed, or fuzz, collected at the Northern Station, Meringa, near Gordonvale, and is then forwarded in airtight tins to the Mackay and Bundaberg Stations, leaving a substantial amount for germination at Meringa. The fuzz is germinated in glasshouses equipped with hot-water heating systems so that the temperatures may not fall to a level likely to damage the young seedlings. When these are several inches in height they are transferred to a rich soil in bottomless pots, four inches in diameter, standing on tables made of concrete slabs. After several weeks, the seedlings, many of which are now commencing to stool, are planted in the field. Numbers put out at the various Stations vary, but average figures would be 9,000 seedlings at Meringa, 7,000 at Mackay, and 5,500 at Bundaberg. These are grown until the following winter or early spring before selections are made, although at Meringa final selection is usually delayed until the first ratoon crop. Selections are planted in small plots of 40-setts—many of these were seen by farmers at the recent Field Days at Mackay and Meringa—and grown for a further season. Selections from these 40-sett plots yield canes for further propagation and eventually the canes are ready for testing on a commercial scale. The process is continuous and in normal times there is a steady stream of canes coming from the Stations for trials in farmers' plots.

The canes for test are grown from seed and then subsequently from setts over a period of years before release into commercial plots, but all observations up to this point have been made on the respective Station and *under a particular set of climatic and agricultural conditions.* It

would be expected that the canes would behave as they had on the Station when taken to areas resembling that in which they had been reared. But the question arises whether they would behave in the same manner in all parts of the region served by the Station. There are only three Stations at present, spread throughout more than ten degrees of latitude, and it is obvious that it is impossible to reproduce on one or other of only three Stations all conditions through such a range of climate and soils. This applies with particular emphasis to the Northern Experiment Station and the region it serves.

The Northern Station is situated in the Mulgrave Mill area near Gordonvale, and is in a locality which has a much drier climate than many other parts of the northern sugar belt. Its average rainfall is approximately 80 inches, of which 60 inches or more occur during the wet season. It could be expected that cane produced under these conditions might not be suitable for areas of, say, 150 to 200 inches with a damper winter and practically continuous growth up to harvest time; they may lodge badly, not germinate under the wet conditions, or may fail to ripen until very late in the season.

There are also the soil conditions to be considered. Meringa Station covers a range of soils varying in both texture and depth, but it does not include any extensive areas equivalent to the gravel soils of Babinda or the red volcanic soils of the Babinda and Innisfail areas. It is obvious that selection on Meringa soils for these other areas is a very difficult task.

Consideration of the facts mentioned has led the Bureau to open a seedling sub-station in a higher rainfall area and a site at the Bartle Frere end of the Babinda mill area has been chosen. The site includes both gravel and volcanic types of soil.

Last spring nearly 4,000 seedlings were potted out at Meringa for planting in this plot. They comprised seedlings chiefly from families which would be expected to produce a short, stocky type of growth not readily subject to lodging. The spring at Babinda was abnormally dry, and it was not until early December that there was sufficient moisture for planting. This is much later than usual, but it is expected that, should such a dry spell occur again, it will be possible to water the plantings and so make them at a more suitable time. The very late planting has, of course, retarded the seedlings considerably and the selection of them will have to wait until the ratoons next year. The canes selected will be planted, sorted out again and then propagated on the site until they are ready for commercial trial. Concurrently, new batches of seedlings will be planted each year, and so the same continuous process as at Meringa will be maintained.

At Mackay there are also difficulties in selecting canes from the poor to medium soil of the Experiment Station for the better class country, and arrangements are now in train to transfer 1,500 potted seedlings from the Station to a site on Lansdowne Road. The soil there is good river alluvial, and has produced heavy crops of cane.

The planting of young original seedlings in localities of different climatic and soil conditions from those at the Stations represents a new departure in the Bureau's seedling raising programme. It will be several years before conclusions can be drawn, but it is confidently expected that the policy will produce results.

Conference of Cane Pest and Disease Control Boards at Innisfail.

By R. W. MUNGOMERY.

The Ninth Conference of Cane Pest and Disease Control Boards was held in Innisfail on 8th May. In opening the Conference, Mr. A. F. Bell (Director, Sugar Experiment Stations) welcomed delegates on behalf of the Advisory Board, and invited them to elect a Chairman to preside over the Conference. Subsequently, Mr. W. L. Poustie was elected Chairman and, on behalf of the Innisfail Canegrowers' Executive, offered his best wishes for the success of their discussion. Mr. R. W. Mungomery then called the roll, and the following delegates were present:—

Messrs. J. P. Reynolds, A. R. Taylor (Mossman), F. M. Barton, F. Ferguson (Hambledon), P. Volp, J. S. Clarke (Mulgrave), W. J. Ryan, J. Greenaway (Babinda), C. K. Simpson, E. Blundell (Goondi), G. R. Blair, E. H. Fox, F. J. McNamara, K. W. West (Mourilyan), W. L. Poustie, G. Wilson, L. F. Richardson, W. Richardson, W. J. Henderson (South Johnstone), J. A. Winter, S. B. Best, G. F. C. Dafforn, J. A. Harney (Tully), W. C. Fraser, E. D. Row (Victoria), K. R. Gard, W. Lyon (Macknade), R. Clarence (Invicta—Ingham Line), D. W. Johnson, W. J. Nelson (Invicta—Giru), F. Reading, J. H. Hawkins (Lower Burdekin), J. L. McGee, H. J. Ramsden, E. A. Friend (Inkerman), F. H. Stevens, J. C. Collier, S. Greenaway (Mackay), J. C. Nicholson, P. C. Brooks (Plane Creek), M. H. Wells (Moreton), A. F. Bell, E. R. Behne, R. W. Mungomery, W. J. S. Sloan, J. H. Buzacott, W. A. McDougall, G. Bates, and H. G. Knust (Bureau of Sugar Experiment Stations). Apologies were received from Messrs. W. C. Griffin (Mulgrave) and J. Alison (Isis).

With reference to matters arising out of discussions of last year's conference, it was pointed out by Mr. R. W. Mungomery that wire netting and similar fencing materials were now out of Government control and the allocation of supplies to farmers depended upon agreement on a quota system reached between the manufacturers and their agents. He further informed the Conference that the Bureau had supported the importation of supplies of the poisons "1080" and thallium sulphate; the latter was now being incorporated in rat baits. It was emphasised that "1080" was an extremely toxic poison. Mr. A. F. Bell explained the amendment to the Sugar Experiment Stations Acts which widened the powers of the Boards for the purpose of subsidising purchases by farmers of equipment and materials used in pest control work. Methods of control of Noogoora burr by introduced seed parasites and weedicides were discussed at some length.

A number of papers dealing with various aspects of pest control were read. Mr. J. H. Buzacott discussed the effects of dry weather on the greyback cane bettle. He indicated that beetle emergences this season had been extensive in many areas. However, immediately following egg laying, soils dried out with consequent desiccation of the eggs.

He believed this to be the main reason why it was unlikely that grub infestation in 1947 in the northern cane-growing areas would be severe. Mr. P. Volp outlined his experience in beetle collecting in the Mulgrave area. A considerable quantity of beetles was collected, but the ultimate effect of this campaign was obscured by the dry weather. He agreed with Mr. Buzacott that desiccation of eggs in the soil was an important factor in lowering the soil population of grubs this season.

Considerable discussion ensued on these two papers, and opinions on the value and method of application of "Gammexane"—the new insecticide, which is at present being investigated—were freely expressed. The Director of Sugar Experiment Stations informed representatives of the various Boards that they would be kept fully informed on the results and progress of the extensive field investigations being conducted by his officers. In view of the fact that Imperial Chemical Industries of Australia and New Zealand were marketing through commercial channels supplies of "Gammexane" dust (1·3 per cent. gamma isomer) he further stated that a circular would be drawn up by his officers summarising their available knowledge on the best method of application to canefields. This circular would be sent out to the interested Boards for their guidance in using any "Gammexane" which they may purchase.

Mr. W. A. McDougall, in his paper on the control of wireworms by "Gammexane" showed that this insecticide was promising for the control of these pests at Mackay. Hitherto, in this district, attempts to check wireworm damage had been mainly directed to the systematic drainage of fields liable to infestation. Two other interesting papers were presented by Messrs. S. Greenaway and J. H. Buzacott. The former outlined his experiences with the yellow-winged locust and its damage to cane fields in the Mackay area. He concluded that the damage caused by these pests did not significantly affect yields. Mr. Buzacott briefly described species of mites which may be encountered in the field by Pest Board officers. As far as was known, these mites were not of great economic importance to cane in Queensland, but it was necessary to be able to distinguish between their webbing and damage, and the symptoms of downy mildew disease.

It was decided that the meeting place for the next conference be Cairns. Delegates desired that, if possible, the meeting be held some weeks later than this year, and final determination of the date was left to the discretion of the Director, Sugar Experiment Stations.

Votes of thanks to the Chairman, and to the Pest Boards of the Innisfail district, were carried by acclamation.

Horse Ailments.

The Common Colics of the Horse.

By R. D. CHESTER, Government Veterinary Surgeon.

COLIC in the horse may be due to a variety of causes, but there are three types most commonly encountered on Queensland farms. These are—

(1) Flatulent Colic—or Wind Colic;

(2) Impaction Colic;

(3) Spasmodic Colic.

FLATULENT COLIC.

This condition is usually caused by the rapid ingestion of lush, gas-forming pasture. Sudden changes of food or exceptionally long periods between feeds are predisposing causes. Any other condition which may set up a stasis of the lower bowel and so prevent the normal passage of gases will, of course, be likely to precipitate an attack of flatulent colic.

Symptoms.

Usually the horse shows slight uneasiness. He is dull in appearance, paws intermittently, and may lie down for short periods. Pain though dull is continuous; there are no spasms of pain. The belly begins to enlarge and becomes drum-like when sounded. Symptoms become gradually aggravated; breathing is difficult because of pressure on the diaphragm.

The horse may sweat profusely. There will be muscular twitching, short "sighing" breathing, staggering, followed by coma and death. Death may take place in a few hours if the condition is not relieved by treatment. This form of colic will respond to correct treatment if it is undertaken soon enough.

Treatment.

A large enema (8 to 15 gallons) should be run into the rectum either directly from a slow-flowing hose or else by gravitation. When giving the enema force must not be applied. A long piece of hose should be used and this is passed as far up to the bowel as possible. Cold water from whatever source available can be used for the enema; the addition of medicaments is not called for.

If the farmer can pass a stomach tube the horse should be given internal treatment by this method, otherwise drenching must be resorted to. To drench a horse, take a long-necked bottle with a piece of hose about six to nine inches long fitting over the neck. Back the horse into a corner and raise his head to about the level of the wither. Insert the bottle with the tubing into the side of the mouth so that the drench is delivered from the tube on to the back of the tongue. Allow the horse to take his time; by trying to force the drench down or tickling the throat one is likely to cause some drench to flow into the wind pipe; this is dangerous and may set up gangrenous pneumonia. The drench

should aim at stimulation of the bowel, the prevention of further gas formation, and alleviation of the pain in the bowel. Give large amounts (half to one gallon) of liquid paraffin together with either one ounce of formalin or half an ounce of salicylic acid. From one to two pints of raw linseed oil can be given in place of the liquid paraffin.

If the bloating has progressed beyond the initial stage there should be no hesitation in puncturing the bowel with a trocar and canula—stab the horse in the right side midway between the last rib and the hipbone, using a long thin canula (8 inches by $\frac{1}{3}$ inch). If the gas does not gush out at the first stab partially remove the canula and reinsert it in another direction; it may be necessary to tap on the left side as well as on the right. Provided the operation is carried out under clean conditions, there is little chance of the wound becoming infected.

When the attack has been relieved, give the horse a few days rest or very light work. Avoid large feeds, but feed frequently and give one or two warm bran mash meals during the 24 hours immediately following the attack.

IMPACTION COLIC.

This is perhaps the most frequent form of colic of farm horses in Queensland. It is a condition which if not recognised at an early stage and treated may lead to death.

Symptoms.

The onset of impaction colic is marked by mild "colicy" pains which may be intermittent. These pains gradually become more severe. Small amounts of faeces may be passed at first but later complete constipation supervenes.

The horse paws and looks at his sides. He gets up and down, seldom remaining still in one spot for more than a few seconds. He will lie flat on his side, his legs paddling and the head is frequently raised around to the side. After 24 hours there is usually a rise in the temperature, and heart beat becomes rapid and irregular. Pain may remain evident for several days before death or recovery.

Treatment.

It is essential to stimulate the bowel. Sedatives should be avoided as most of these tend to prevent bowel movement and so aggravate the condition. If the horse becomes violent and seems likely to injure himself, give one and a-half ounces of chloral hydrate in a ball. Avoid opiates. In the past these have frequently been given to horses with colic; however, they are definitely detrimental in this type of colic. Give a ball containing one ounce of aloes and one-eighth ounce of calomel; follow by balls containing two ounces of ammonium carbonate and one ounce of pulverised nux vomica.

If a drench is preferred, use liquid paraffin or raw linseed oil as for flatulent colic, but add the following to the drench:—

Sweet Spirits of Nitre—1 oz.;

Turpentine—2 oz.;

Tincture Nux Vomica—1 oz.

If a stomach tube can be passed wash the stomach with from one to two gallons of saline solution.

Large enemas of cold tap water are indicated; they should be administered in the same way as described for flatulent colic.

Manual examination of the bowel through the wall of the rectum may assist in locating the source of the impaction.

SPASMODIC COLIC.

This is quite common in horses in Queensland. It is caused by severe spasms or contractions of the intestines. The conditions responsible for the intestinal spasms are not clear but it is usually associated with sudden changes in the type of food, feeding at irregular intervals or feeding and watering horses immediately after exhausting work.

Symptoms.

This type of colic is sudden in its onset. This distinguishes it from flatulent colic and impaction colic. The horse may be at feed. He will suddenly stop, paw the ground, and look around to his side. Pain quickly becomes severe; he will lie down and roll vigorously, get up and go down again quickly. He may resume feeding between intervals of severe pain. As the attack progresses the intervals between painful attacks become shorter. The animal will become quite violent—throwing himself down, rolling, and hitting his head on the ground. When standing he will paw vigorously and strike with the fore feet. He will sweat profusely and make frequent attempts to pass water.

The attempts to pass water may lead farmers to the conclusion that the horse has a blockage in the bladder, and so this condition is sometimes called "water gripes." However, there is no trouble with the bladder; the symptoms shown result from bowel pain and not bladder pain.

There is seldom any rise in body temperature.

Treatment.

It is usually necessary to give some sedative to prevent the horse becoming too violent. Only chloral hydrate should be used. One to one and a-half ounces of chloral hydrate should be given, by ball or stomach tube. Give linseed oil and stimulants as for impaction colic.

Enemas through the rectum are helpful. Chloral hydrate may be given per rectum if it is not possible to give a ball or pass a stomach tube.

After recovery takes place hard work should be avoided for a few days. The bowels should be kept soft by use of large quantities of bran and the horse should be well protected against sudden cold changes.

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